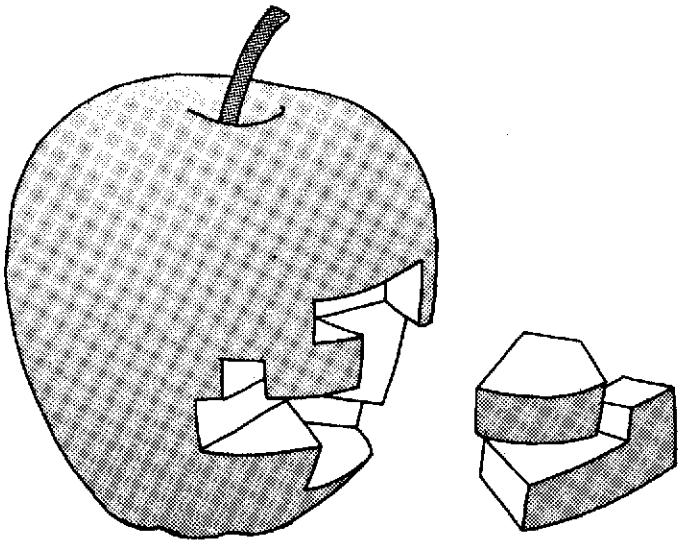
AppleChips™



Troubleshooting Guide for Apple][&][Plus Computers

By
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STOP!

READ THIS

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Limited Warranty and Limit of Liability

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Apple-Dayton *AppleChips* Kits are sold as an aid to Apple II users who wish to perform chip-replacement repair themselves. In no event will Apple-Dayton, Inc. or its distributors be liable for direct, indirect, incidental or consequential damages resulting from use of the *AppleChips* Kits, even if Apple-Dayton, Inc. has been advised of the possibility of such damages. Except as provided in the limited warranty, the entire risk for Kit use is with the buyer, and the buyer (and not Apple-Dayton, Inc., its distributors or its retailers) assumes the entire cost of all servicing, repair, or correction and any incidental or consequential damages. Some states do not allow the exclusion or limitation of implied warranties or liability for incidental or consequential damages, so the above limitation or exclusion may not apply to you.

Apple-Dayton, Inc. warrants the integrated circuits provided in *AppleChips* Kits to be of commercial quality and to be functional at the time of delivery. However, chips which have been damaged by user error (e.g. plugging a chip in backwards, or in the wrong socket, or with the power on) are NOT replaceable under warranty. This warranty is valid for one year from the date of purchase. ICs for warranty replacement should be sent, postage paid, to Apple-Dayton, Inc. for testing.

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Apple-Dayton is a non-profit microcomputer users group.

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AppleChips Troubleshooting Manual

1.0 INTRODUCTION

One of these days a cry will be heard throughout your house, something like "HELP!!! THE COMPUTER DOESN'T WORK!!!". The Apple II which you can no longer live without needs service to get it operating again. What do you do now??? You have a rather limited number of options available to get your computer fixed:

1. You can walk away and forget about computers altogether. (But everyone knows you're hooked).

2. You can take it to a computer service center. This is a great idea if your system is still under warranty, but if your warranty has expired you can expect to pay a healthy price to have it fixed. (Probably more for one visit than the entire cost of your *AppleChips* Kits).

3. You can try to locate a friend or another computer club member who has the ability and time to fix your computer.

4. You can use a commercial diagnostics program. However, most of the programs are expensive and only help identify the problem, not fix it. The repair will mean added expenses.

5. You can fix it YOURSELF!. In all but a few rare situations you can, indeed, get your computer running again yourself. And best of all, you will save time and money as well as learn something about the inner workings of your Apple in the process.

If your computer is not under warranty you have probably already eliminated options 1, 2, and 3 as either too expensive or impractical. Unless there is just a minor problem the software solution will not help, since the software won't run. The remainder of this manual will detail the "HOW-TOs" of fixing your Apple II YOURSELF.

The Apple-Dayton *AppleChips* Kits and this manual were developed to help you fix single integrated circuit (IC) failures (the most common kind of failure) and some double or multiple IC failures.

1.1 MANUAL ORGANIZATION

This manual is divided into nine main sections, as summarized below.

Section 1 INTRODUCTION. General comments.

Section 2 INITIAL TROUBLESHOOTING. This section helps you identify which part of the system is causing the problem, e.g. motherboard, peripheral card(s) or disk drive(s).

Section 3 MOTHERBOARD TROUBLESHOOTING. This section helps localize problems on the motherboard and repair them using the *AppleChips* Motherboard Kit.

Section 4 Disk II DISK DRIVE TROUBLESHOOTING. Section 4 provides instructions on finding and repairing problems with the Disk II drive and/or Apple Disk Controller card using the *AppleChips* Drive/Controller Kit.

Section 5 TROUBLESHOOTING EXAMPLES. This section presents some case histories of repairs which were made using ChipKit's troubleshooting procedures (and some which weren't chip failures).

Section 6 HANDLING INTEGRATED CIRCUITS. This section shows how to correctly identify, handle, remove and replace IC chips.

Section 7 RAM TESTING. Section 7 presents some test code which can help diagnose memory problems.

Section 8 REFERENCE DATA. This section presents a list of useful reference books and sources for replacement chips.

Section 9 ABOUT APPLE-DAYTON. This section discusses the chip kit project and Apple-Dayton club membership.

The procedures detailed in this manual are ones that have been used successfully in previous troubleshooting activities. Many were learned through "trial-and-error" experience. Some were discovered in the myriad of magazines and books that have been published. Others were provided by members of Apple-Dayton. These procedures are not all inclusive and new or improved methods will surely come along. Please let Apple-Dayton know of new and better techniques that you discover. They may be added to later revisions of this manual.

This troubleshooting guide assumes an Apple][Plus computer (with Applesoft in ROM), an Autostart Monitor ROM (automatically boots disk), at least one disk drive, a video monitor, and some unspecified (number and type) peripheral cards. The "system prompt" is a left bracket (]). Other configurations, such as an Apple][(Integer) computer or no disk drive, will require slight modification of the procedures.

1.2 GETTING STARTED

Carefully examine the ICs ("chips") located on the conductive foam chip carrier. Check that the chip type numbers printed on the chips correspond to the type numbers on the paper chip locator sheet mounted on the foam carrier. (If you are unfamiliar with chip numbering conventions or if discrepancies are found, GOTO Section 6.0. Some chips have several type numbers, depending on manufacturer.) Errors should be reported to Apple-Dayton by mail for corrective action.

1.3 WARRANTY CONSIDERATIONS

Before starting work on your system using *AppleChips* Kits, check the system or peripheral warranty! Attempts at self repair will usually void a warranty, and warranty service should be used if possible. Check the instruction manuals for each system component (Apple][computer, disk drives, peripheral cards, etc.) for the terms of the warranties, then check the sales receipts for each item to see if it is still covered (you did save the receipts, didn't you?). You may be able to use the troubleshooting procedures in this manual to isolate the problem and, if the problem is a peripheral card, run your system without it for a while. However, if unscrewing/opening a piece of equipment voids the warranty, you should probably not do it. You're gambling that you can fix it. Use the warranty! Work with the dealer or manufacturer. Make sure you understand what part of the service cost is covered by the warranty.

Also, please read the warranty for *AppleChips* Kits at the front of this manual. Chips which are handled and installed properly and which prove to be defective are covered by our warranty. Chips which have been abused, ESPECIALLY those installed backwards and powered up, are NOT covered. We rely on our customers to respect this provision.

1.4 *AppleChips* KIT TYPES

There are currently two *AppleChips* kits available from Apple-Dayton, as follows:

Motherboard Kit, Type MK-2-1
Disk Drive/Controller Card Kit, Type DK-2-1

The Motherboard Kit is designed for servicing both old and new Apple][and Apple][+ systems (but NOT the Apple //e). The number of chips per part type is related to the number used on the motherboard, i.e., 1 per kit for 1 or 2 per system, 2 per kit for 3 or more per system. Note that an Apple motherboard design change replaced two type 8T28 chips with one type 8304 chip. To support both versions, both chips have been included. Also, we have included one type 74LS125 chip, which is used in the Disk][. It does not appear on the motherboard, but is included because it is the most frequently blown disk drive chip. The 6502 microprocessor is not included (we have never seen a failure), nor are the Apple ROMs D0-F8 (copyrighted firmware) or character generator chip. The kit also does not contain parts for the keyboard or power supply. It does include 41 ICs, an IC puller and this manual.

The Disk Drive/Controller Kit is designed for servicing one Apple brand disk controller card and two Apple disk drives. Extra type 74LS125 chips are included because they are the most frequently blown due to plugging the cable into the controller card incorrectly. Only one type MC3470 read amplifier chip is included due to its high cost. The kit includes 15 ICs and this manual.

AppleChips Kits provide 32 of the 40 chip types found on the motherboard of all Apple][/][+ computers, and 10 of the 12 chip types found in Apple Disk][subsystems. Failures in ROM's, power supply, or keyboard, or problems which cannot be resolved using procedures in this manual, will require dealer service. Using *AppleChips* Kits and this manual will dramatically reduce the need for dealer service.

2.0 INITIAL TROUBLESHOOTING

There are two immutable laws that must never be broken:

2.1 **WARNING!!** ALWAYS **TURN OFF** THE COMPUTER'S POWER BEFORE YOU INSERT OR REMOVE ANYTHING!!!

> This law needs no more comment, except to say that quite often it is not following it that gets users into trouble to begin with.

2.2 **NEVER** OVERLOOK THE OBVIOUS. CHECK AND RECHECK EVERYTHING! (Or, Murphy's law **always** works)

> By "Never Overlook the Obvious" we mean such things as:

a. Is the wall outlet "hot", are the plugs properly inserted into wall socket and computer, and is the power switch on?
b. Is the monitor (or TV and modulator) connected and turned on, and is it tuned properly?
c. Are the game paddles properly plugged in and are you using the correct one?
d. Are you accessing the correct slot for the device you are addressing?
e. Do you have the correct DOS (3.2 or 3.3) active?
f. Is the disk inserted correctly?
g. Is the disk drive door closed?
h. Have you read the instruction manual and are you using the item correctly?

This list is not meant to be complete, but rather, it will give you some idea of simple things that can go wrong, causing it to appear that the computer has gone bonkers.

EXAMPLE: The computer seemed to be locking up in the middle of a program. The image on the screen would freeze and the computer would have to be shut down and restarted. Bad chip? Bad card? No, the wall plug had worked loose and every time the table on which the computer was sitting moved slightly it would move the wall plug, causing a momentary power disconnect! Moving the table away from the wall plug solved this problem.

Once the obvious items have been checked you can get started fixing your broken computer. The method we will use has been called "non-problem elimination". This method systematically eliminates all subsystems within the computer that are functioning properly. This minimizes the time you will spend checking "good" components.

It is a good practice to discharge any static electricity in your body (from walking across the carpet, etc.) by touching the power supply after turning the computer off. Some of the IC chips can be easily damaged if this static electricity is applied to them. Besides, it gives you a second chance to make sure that you have turned OFF the computer. See Section 6 for additional information on grounding.

Methodically and cautiously check all your connections starting at the wall plug. Do not overlook the connection between the power supply and the motherboard. Gently but firmly push each motherboard chip into its socket. This is often all that is required to fix intermittent problems. Caution should be used, however, in pressing chips and inserting cards. Excess force could possibly flex the motherboard enough to break a printed circuit trace.

2.3 INITIAL ONCE-OVER

The first step in troubleshooting is to do a thorough visual inspection looking for any loose chips, bent pins, burnt areas, blistered or cracked chips, and any other obvious damage. Sometimes this will be all the troubleshooting that is required.

If you KNOW the source of the problem, such as inserting or removing a card with the power on, or plugging the disk drive cable into the controller board wrong, then a slightly modified procedure is used. Remove the circuit card involved, either peripheral or drive controller, and proceed with the tests below. Once the system is working you can service the card(s).

2.4 POWER SUPPLY TROUBLESHOOTING

Once the visual check is finished, proceed through the flowchart in Figure 2.1. The rectangles in the figure indicate actions that you will perform, and the diamonds indicate yes or no decision points. Note that a thorough test of some items requires an electronic test instrument (Volt-Ohm-Milliamp multimeter), and a card extender is recommended for electronic testing of peripheral cards. If you don't have the instruments and electronic experrience, dealer service may be required for certain types of problems. THE FIGURE ASSUMES PROPER POWER ON/OFF SWITCHING BETWEEN STEPS!

GENERAL: Most of Apple's Level 1 service procedures are based on substitution on known good items (e.g. power supply, ROMs, peripheral cards). If you have a friend with an Apple, you can often save a lot of time and trouble by isolating your problems through substitution of known good parts from a working system rather than exhaustive electronic testing (especially if you don't have electronic test instruments). In fact, this is the principle upon which the *AppleChips* Kit is based.

Check that the wall socket is 'hot', the power cord is plugged in tightly, and disk drive and monitor cables are connected correctly.

The following notes refer to the boxes on Figure 2.1, "Power Supply Test":

FIGURE 2.1:
Box 3. A failed power supply switch is often the cause of a "dead" Apple. The switch can be replaced by a skilled technician (requires drilling out rivets), but generally the supply must be replaced. It is a good failure prevention practice to use another switch (e.g. a switched plugstrip or a cooling fan with switched outlets) to power up your system, BEFORE the power supply switch fails. Another sign of trouble is a distinctive ticking or buzzing noise coming from the power supply. This usually indicates an output overload or a short circuit.

Box 4. Display of any characters on the screen or the drive attempting to boot USUALLY indicates that the power supply is OK.

Box 5. Simple system tests include (a) type in and run short Applesoft programs, (b) load and save files to disk. If this much works, you may be able to run diagnostic software if you have it. Try the system with and without the disk controller card plugged in. If the system works with the disk controller out, go to section 2.5 for peripheral card checks and section 4.0 for disk drive troubleshooting.

Box 7. A power supply short could be on a card.

Box 16. The only SURE way to know about the supply is to measure its four output voltages using a multimeter (Radio Shack or equal, about $20.) See Figure 2.2 for the wiring of the peripheral connectors (i.e. "slots"). Measuring power supply voltages is DANGEROUS due to the possibility of shorting power leads to other I/O leads with the voltmeter probes. If you do it, use extreme caution! It is helpful to place a 0.5" by 2.6" cardboard strip in the connector to help protect against shorting.

Measurements may be made on any slot. All measurements are relative to system ground, connector pin 26 or the video jack housing (NOT the power supply case!) Voltages should check as follows: (a) pin 25, +5 volts, (b) pin 33, -12 volts, (c) pin 34, -5 volts, (d) pin 50, +12 volts. Voltage readings should be within 5% to 10% of these figures. BE VERY CAREFUL! MAKE SURE YOU DON'T SHORT I/O PINS TOGETHER WITH THE

VOLTMETER PROBE! If you are not SURE of your skill, GO TO YOUR DEALER!

Box 18. New non-Apple brand power supplies are available by mail order for under $100. Dealers will often take an unopened/unmodified bad supply as a trade-in on a reconditioned supply for around $110.

Once you have worked your way through Figure 2.1 you will have either fixed your problem or eliminated the power supply as the problem area.

2.5 PERIPHERAL CARD TROUBLESHOOTING

Next, let's consider the most likely cause of problems with a non-working computer: one or more of the peripheral cards in the slots in the back of your computer. (This section assumes the power supply is OK and the system is back in its normal configuration). The problem could have been caused by inserting or removing a card with the power on (violation of Law #1).

Even if the power was off the card may not have been inserted properly into its slot. The fifty pins are very close together and if the card is not seated completely into the slot a short may occur. Another source of peripheral card problems (this one is very insidious) is caused by the buildup of an insulating film ("dirt") on the contacts, requiring contact cleaning.

The following notes refer to the boxes of Figure 2.3, "Peripheral Card Evaluation", which describes graphically the following procedures.

FIGURE 2.3:
Boxes 1-3: TURN OFF THE POWER! Write down which peripheral cards are in each slot, then remove all of the cards (YOU DID REMEMBER TO TURN OF THE POWER FIRST, DIDN'T YOU?). If you were working with a card when a problem occurred, set that card aside. If you accidently inserted or removed a card with the power on you may have damaged a chip on that card, on another card or cards, and/or on the Motherboard. After you have removed the cards turn the power back on. Did the system prompt reappear? (also try pressing RESET). If NOT, then motherboard repair is indicated.

Boxes 4-8: Turn the power OFF, reinsert the cards in their original slots and turn the power ON. Did the system prompt appear? If the system now operates normally the failure was probably due to a poor card/connector contact, and card edge connector cleaning is indicated. If NOT, then turn off the power, remove a card, and power up. Continue this process of

removing cards until the system starts working or until you have removed all of the peripheral cards.

Box 9: If you find a card which, when removed, allows the computer to operate again, then: TURN OFF THE POWER and reinsert that card into the SAME slot. Power up again to see if the system failure reoccurs. If it fails again, skip to Box 13. If the system now works, continue with Box 11.

Boxes 11,12: If reinserting the card and turning the power on restored your system to normal, your card is probably the victim of a "dirt" film that has accumulated on the 50 pin connector. Removal and insertion of the card will often scrape away enough of this film to cause the computer to begin functioning again. In this case, TURN OFF the power, remove the card and clean the contacts using a commercial contact cleaning cloth. If a commercial cleaner is not available you may also use denatured alcohol and a cotton swab.

Contamination is not limited to peripheral cards; it can also appear on the thin leads on the IC chips. To help prevent contamination buildup or corrosion, always avoid touching the contacts on the peripheral cards or chips.

If intermittent contact appears to be your problem, first try pushing every IC and peripheral card firmly into its socket. As a last resort you can clean every contact in the system, both peripheral card contacts and IC pins. For cards, burnish each contact gently using a soft pencil eraser, rubbing lengthwise on the contacts. Remove any eraser residue with denatured alcohol (Methanol) (NOT rubbing alcohol!). IC leads can be cleaned similarly, one by one, very gently, but extreme care must be taken to avoid bending the delicate leads. Do not remove more than one IC at a time, and make SURE it goes back in facing the right way!. Observe static electricity precautions. See Section 6 for IC handling procedures. Note that Apple IC sockets are only good for a limited number of insertions, so don't pull chips unnecessarily.

If the system works when a card is wiggled or pushed to one side (with power on; use care), dirty contacts are indicated. If contact cleaning only helps for a few days (as with some older Apple cards without gold plated card edge contacts), the card may have to be replaced.

After the contacts have been cleaned and the cards have been reinserted into their slots, we are ready to do a system check to insure that all is well and that troubleshooting has been completed.

Boxes 13-14: Turn the power OFF, remove the offending card and reinsert it into another slot. Turn the power back on. If the computer does NOT work the card is probably bad and requires service. If the computer and card DO work with the card in another slot then there is at least one chip on the motherboard that is bad (or the slot connector is bad).

Boxes 17,18,20: To confirm the above conclusions, turn the power OFF again, insert another (good) card into the "suspect" slot and turn the power back on. If the computer and/or that card do NOT function properly, the slot is apparently bad and you may now concentrate on the motherboard testing (Section 3). The most likely defect is in the DEVICE SELECT area (chip locations H2 and H12 on the motherboard), but that is covered in Section 3.

Boxes 17,18,19: If the new card DOES work in the "suspect" slot, you can be fairly certain that the slot is OK and that the "suspect" card is the culprit. To be really sure, try other good cards in the "suspect" slot.

If you have removed ALL your peripheral cards and still have not discovered the problem, remove the game paddles and any other extras (like keyboard enhancers or keypads), one at a time, until you are down to a bare motherboard. If these actions fail to uncover the problem you will have narrowed the search to the motherboard. Faults may be due to defective chip(s) and/or faulty connections (including broken printed wiring traces), or defective transistors, resistors, capacitors, etc. on the motherboard.

All of the efforts so far should have either found a defective peripheral card or eliminated them from consideration as the reason the computer is not functioning normally. What lies ahead is an exploration of the motherboard itself. In the next section, we will present a simplified road map through the 87 IC chips on the motherboard. It is not as awesome as it may first look.

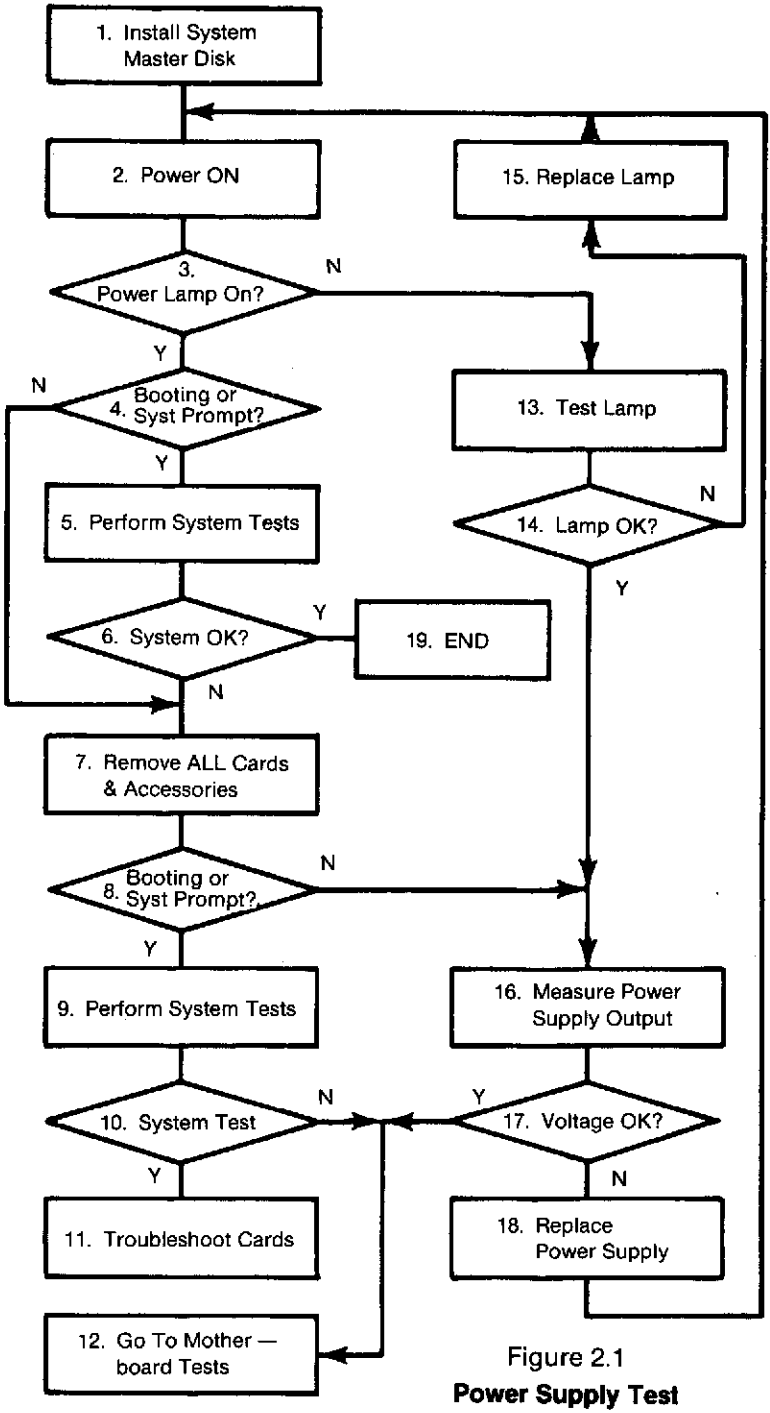
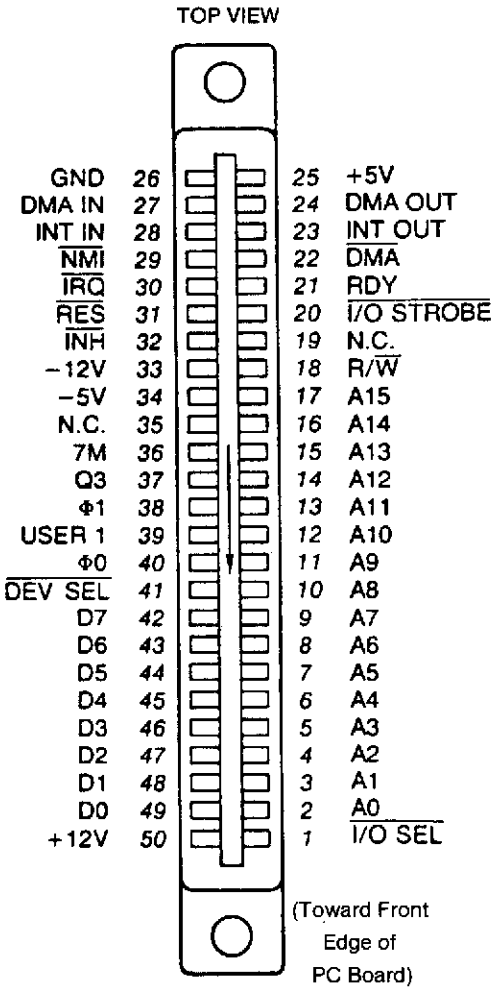
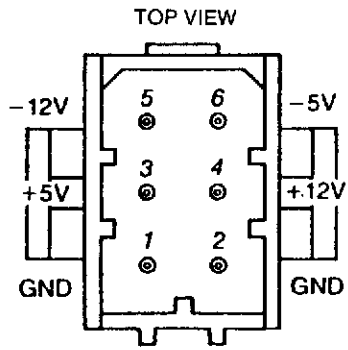


Figure 2.1
Power Supply Test



PERIPHERAL CONNECTORS
(EIGHT OF EACH, LOCATIONS J2 TO J12)



POWER CONNECTORS
(LOCATION K1)

Figure 2.2

Peripheral and Power Connectors

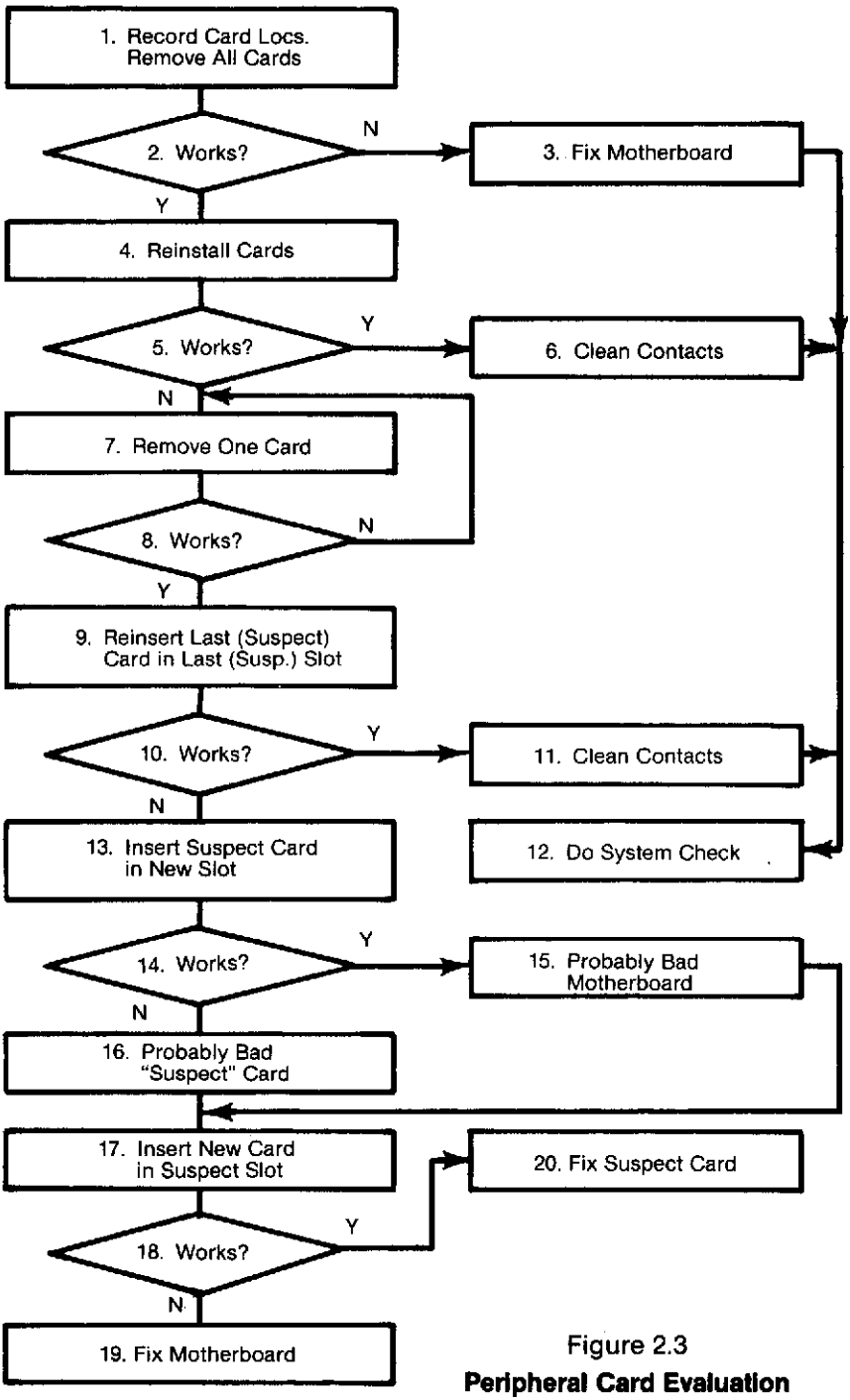


Figure 2.3
Peripheral Card Evaluation

3.0 MOTHERBOARD TROUBLESHOOTING TECHNIQUES

There is test equipment available commercially that will isolate a failed IC on the motherboard, and will probably do it faster than the method presented here. However, this equipment costs in excess of $500.00 and our purpose is to fix the computer with a minimum of expense. The method presented here should require only a little of your time and the Apple-Dayton *AppleChips* Kits.

3.1 GENERAL MOTHERBOARD REVIEW

Before jumping into the actual steps of troubleshooting the motherboard, let's become more familiar with the board's layout and the components contained on it. Please refer to Figure 3.1 in this manual and Figure 10 on page 89 of the APPLE][REFERENCE MANUAL as we discuss the various areas of the Motherboard. Since your motherboard may be a later revision than the one that is shown in the figures mentioned above, one or two items may be in slightly different locations, and you may not have the 3 RAM Configuration Blocks located along the left side of the motherboard. All revisions of the motherboard should be similar enough for this discussion, however.

The motherboard map in Figure 3.1 is oriented with the bottom of the figure corresponding to the front edge of your motherboard (the area under the keyboard). Notice the locating grid markings along the front of the board (numbered 1 through 14). You probably can't see these on the motherboard itself because they are under the keyboard, inside the case, but they are there and you will find them easily when we get to the motherboard troubleshooting activities. The locating grid markings are alphabetical up the left side of the motherboard (If you have ever located a street address on a city map you will have no trouble locating an IC on the motherboard).

The five crosshatched locations in Figure 3.1 indicate places where external devices are connected to the motherboard (K1 - the power supply; K14 - the TV rf modulator; J14 - the game paddle; A7 -the keyboard; and A14 the speaker). The 8 long rectangles, positioned vertically along the top (back) of the figure represent the 8 peripheral connectors ("slots"), numbered 0 through 7.

In the upper-right hand corner are the connections for the cassette tape recorder INput and OUTput and the video MONitor connection.

The largest chip on the motherboard is at location H8 (row H, column 8). It is the 6502 microprocessor chip which is the "brain" of your computer. Everything else on the motherboard is there to service the needs, whims, and desires of the 6502!

Note that the notched (pin 1) end of all ICs except the 6502 (at H8) and the character generator chip (at A5) face FORWARD, toward the keyboard. Always remember this when replacing chips! Refer to Section 6 for more information.

The onboard Read Only Memory (ROM) chips are found in row F, locations F3-F11. The ROM chip located at position F3 is the system's Monitor ROM ("Autostart" ROM with Apple II Plus and "Normal" or "old" Monitor ROM with INTEGER BASIC Apple II computers). The other five chip locations F4-F11 hold either five language ROMs for the Applesoft language (Apple II Plus), or three ROMs for the Integer language (Apple II).

Rows C, D, and E, columns 3 through 10, contain the Random Access Memory (RAM) chips that provide the temporary storage your computer uses to store the Disk Operating System (DOS) and whatever program you wish to run. The information stored in these RAM chips disappears when the power is turned off. Each row of 8 chips makes up 16K bytes of memory. The three rows in total give you a 48K system.

Your system may or may not have the three "RAM Configuration Blocks" which are shown at locations D1, E1, and F1. The newer motherboards (Rev.7 & up) have been produced without them and without chip E2. You can read all about configuration blocks on page 70 of the Apple II Reference Manual, if you're interested.

The large chip in location A5 is the Character Generator ROM which forms the characters displayed on the display screen.

Note the area at H10 and H11. Early motherboards used two data buffer chips, IC type 8T28, while later boards use one chip, IC type 8304. The motherboards will look a bit different, but both chip types are included in the *AppleChips* Motherboard Kits; just use the right one. Note that other chip number discrepancies are probably due to use of equivalent, interchangable part types, as described in Section 8.

The tour over, we will concentrate our activities and attention on the 55 ICs (other than microprocessor, RAM, ROM and Char. Gen.) that do all of the supporting chores.

As you have probably noted from the "motherboard tour", the first two rows of chips are very hard to get at with the computer's housing (case) on. If your troubleshooting requires that a chip in rows A or B be replaced you will have to remove the cover and housing to allow access to the chips.

This operation is necessary ONLY if you must work on rows A and B.

To remove the housing:

1. Unplug the computer from the wall socket and disconnect the power cord.
2. Remove lid.
3. Remove all peripheral cards.
4. Unplug all external cables (monitor, disks, etc.).
5. Carefully turn the computer over on its top, on a soft surface (at this point there should be no cables attached to or extending from the computer).
6. Remove the four round-head screws along the front edge of the base.
7. Remove the six flat-head screws along the three outside edges of the metal base.
8. Now, holding the computer housing and base firmly together, return it to its upright position.
9. Carefully raise the front edge of the housing about 3 inches and notice the cable that is attached to the motherboard at location A7. This is the interface cable between the keyboard and the motherboard. DO NOT disconnect this cable. We will need to use the keyboard during our troubleshooting activities to determine whether we have found the faulty IC. Set the housing on the base.
10. Reinstall the cards, reconnect the power cord and the other external cables.

3.2 MOTHERBOARD TROUBLESHOOTING

We are now ready to begin a repeating process of "educated trial and error" to remove and replace suspect IC chips on the motherboard. Be sure to make written notes of what you're changing; as you change it, so it will go back together afterwards!

****

In the Troubleshooting Guide (Figure 3.2) find the SYMPTOM that most closely resembles your problem. Concentrate initially on those chips that are associated with that symptom.

Use the motherboard map (Figure 3.1) to find the chip to change.

****

1. TURN OFF your computer.
2. Observe proper static electricity precautions (See Section 6).
3. Locate the suspect chip to be replaced on the Motherboard.
4. Remove the suspect chip with your IC puller and store in a piece of anti-static foam (e.g. the foam used in your ChipKit). Do not mix old chips and new chips! (It is helpful to place a 3/16" square piece of diskette label on each new chip so they can be easily

spotted on the motherboard).

5. Install the new chip. Use a bright light on the motherboard, and watch for bent under pins or pins which miss the socket on one side.

   Is the chip oriented properly? Does it have the same identifying numbers on it (or is it a valid substitute)? Check the numbers AGAIN!! They are small.

   If the rows of pins on the new chip are too far apart to allow easy insertion into the socket on the motherboard you can GENTLY squeeze the rows of pins together with your (pre-washed) fingers until they are the right distance apart to line up properly with the holes in the socket.
6. Once the new chip is installed properly, check to make sure no foreign objects are laying on the motherboard. Turn on the computer. Note the response.
7. If the response is the same as it was before, or is not proper, go back to step 1 above and repeat the procedure until you have located the faulty IC(s) or until all chips associated with the symptom have been replaced.
8. Leave the new chips in place for now, but KEEP A LIST OF WHAT YOU'VE CHANGED, AND KEEP THE OLD CHIPS YOU'VE REMOVED SEPARATE.
9. If after replacing all the chips identified with a symptom you still have not resolved the problem, evaluate the other symptom descriptions for possible applicability to the system fault and "Remove and Replace" these chips following the same procedures.

This probably sounds like a slow, tedious process, and, in fact, it is! But with a little care and patience you will be able to work your way through the symptoms and should have reasonably good luck locating and replacing the defective chip(s). Do not get discouraged if you don't find the faulty chip on the first try. If you are careful and methodical you will almost always be able to find the problem chip(s)!

After you have located and replaced the faulty chip(s) you can begin to rebuild your computer system. It is recommended that you do so ONE STEP AT A TIME and recheck your system performance after each chip is replaced. Swap the old chips back into the system in reverse order, using your removal list. This will help insure proper reassembly and it will also quickly reveal any additional bad chips which were masked by other bad chips further down the replacement list. Do a quick system test after each chip replacement. Be sure to discard the bad chips and return the good ones to your *AppleChips* Kit. You may choose to leave the new chips in the system, with the understanding that some of the old chips may be bad.

If swapping of all chips does not fix the computer, the problem could be a multiple chip failure or failure of the 6502 CPU, ROMs, character generator, motherboard circuit board, or keyboard. Dealer service is indicated. Note that with TWO *AppleChips* motherboard kits you can replace all but one of the small logic chips at one time. This will find virtually all multiple logic chip failures.

If the base was removed, reattach it to the housing by reversing the removal procedure above.

Replace the peripheral cards one-by-one (and don't forget to power off each time). Check system operation after each card replacement. If a bad card is found, the same chip "Remove and Replace" procedure works well on those peripheral cards which have their ICs mounted in sockets (if you have the spare chips). If they are not socket mounted you are encouraged to return the card to the factory for repair. If you can't return the card, and have to unsolder and replace a chip, consider installing an IC socket in its place on the card and insert the new chip into the socket. This will help the next time you have to replace the chip. Use a good quality double-wipe socket.

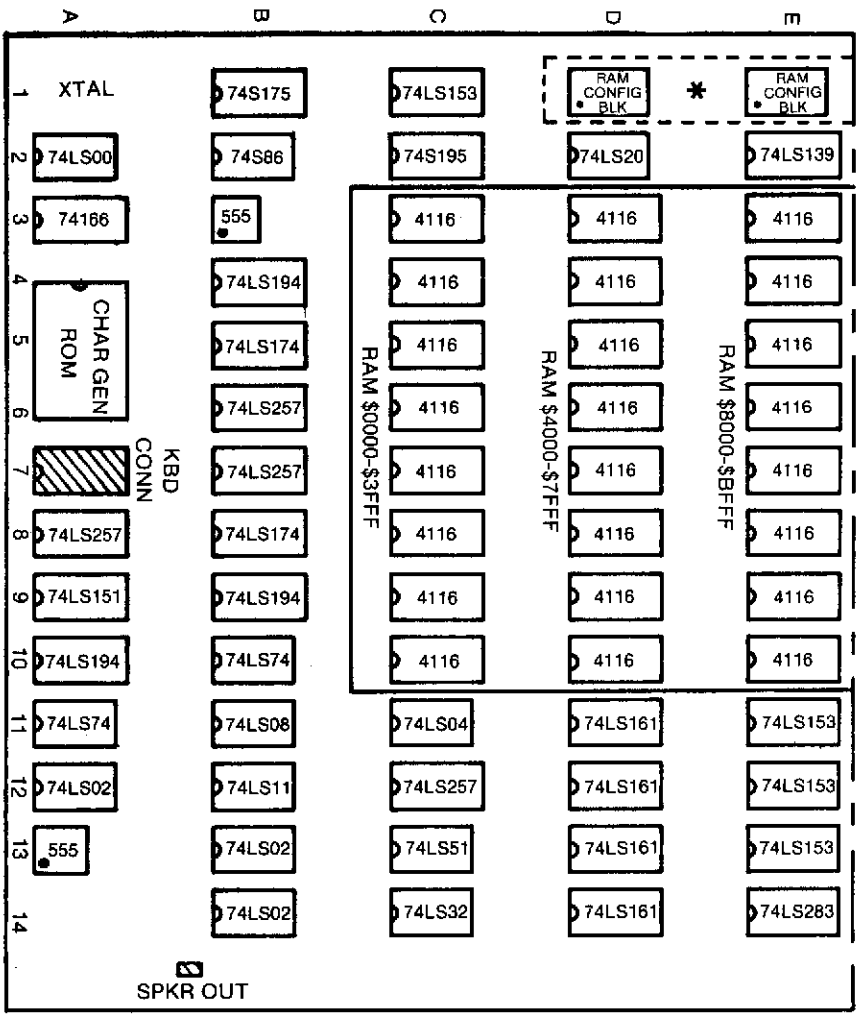


Figure 3.1
Motherboard Chip Map

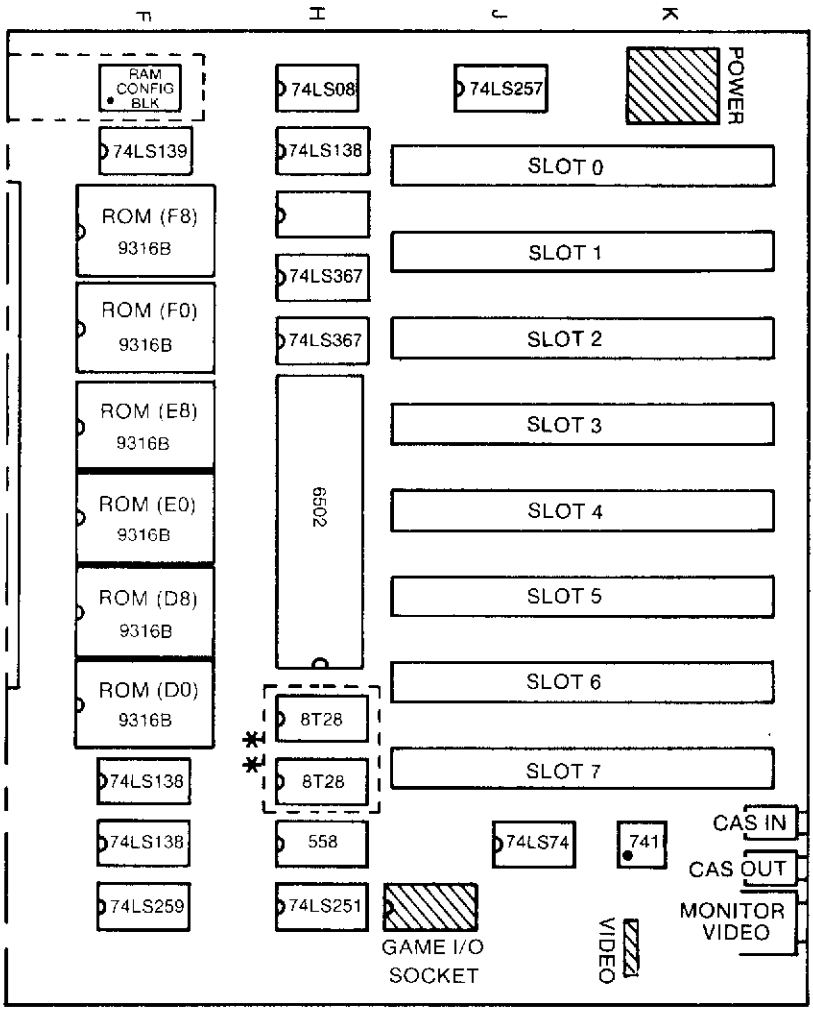


Figure 3.1
Motherboard Chip Map

SYMPTOM	REPLACE THESE IC's ONE AT A TIME		
1. TOTALLY DEAD SYSTEM (Power Light is ON)	A2 - 74LS00	B1 - 74S175	B2 - 74S86
	B13 - 74LS02	C1 - 74LS153	C2 - 74LS195
2. NO RESET or NO RESPONSE	B5 - 74LS174	B6 - 74LS257	B7 - 74LS257
	B8 - 74LS174	B11 - 74LS08	C14 - 74LS32
	E11 - 74LS153	E12 - 74LS153	E13 - 74LS153
	F12 - 74LS138	F13 - 74LS138	F14 - 74LS259
	H1 - 74LS08	H3 - 74LS367	H4 - 74LS367
	H5 - 74LS367	H8 - 6502	H10 - 8T28
	H11 - 8T28	H14 - 74LS251	
	System RAMs C3-C10, D3-D10, E3-E10		
	System ROMs F3 - F11		
3. NO VIDEO (Speaker does "BEEP")	A2 - 74LS00	A8 - 74LS257	A9 - 74LS151
	A10 - 74LS194	B2 - 74S86	B10 - 74LS74
	B12 - 74LS11	B13 - 74LS02	C2 - 74S195
	C11 - 74LS04	D11 - 74LS161	D12 - 74LS161
	D13 - 74LS161	D14 - 74LS161	
4. NO TEXT MODE	A3 - 74166	A5 - 2513	A8 - 74LS257
	A9 - 74LS151	A10 - 74LS194	B2 - 74S86
	F13 - 74LS138	F14 - 74LS259	
5. HIRES or LORES GRAPHICS problems	A8 - 74LS257	A9 - 74LS151	A10 - 74LS194
	A11 - 74LS74	B4 - 74LS194	B9 - 74LS194
	B10 - 74LS74	B12 - 74LS11	C11- 74LS04
	C12 - 74LS257	F14 - 74LS259	H1 - 74LS08
	J1 - 74LS257		
6. RAM PROBLEMS	A2 - 74LS00	B5 - 74LS174	B8 - 74LS174
	C14 - 74LS32	D2 - 74LS20	E2 - 74LS139
	E11 - 74LS153	E12 - 74LS153	E13 - 74LS153
	E14 - 74LS283	F2 - 74LS139	H1 - 74LS08
	RAM in Rows C, D, E		
7. ROM PROBLEMS	F12 - 74LS138	H1 - 74LS08	ROM - F3-F11
8. VERTICAL or HORIZONTAL SYNC PROBLEMS	A2 - 74LS00	A3 - 74166	A12 - 74LS02
	B11 - 74LS08	B12 - 74LS11	B13 - 74LS02
	B14 - 74LS02	C11 - 74LS04	C13 - 74LS51
	C14 - 74LS32	D11 - 74LS161	D12 - 74LS161
	D13 - 74LS161	D14 - 74LS161	
9. GAME PADDLE PROBLEMS	F13 - 74LS138	H13 - 558	H14 - 74LS251
10. SPEAKER PROBLEMS	A12 - 74LS02	B6 - 74LS257	B7 - 74LS257
	B10 - 74LS74	C11 - 74LS04	F13 - 74LS138
11. PERIPHERAL CARD IN SLOT WON'T WORK	H2 - 74LS138	H12 - 74LS138	

EQUIVALENT REPLACEMENTS: 9334=74LS259, 8T97=74LS367

Figure 3.2

Motherboard Troubleshooting Guide

4.0 DISK II DRIVE & CONTROLLER TROUBLESHOOTING

In this section some preventive maintenance procedures will be discussed, followed by some repair procedures that may prove useful should your system diagnosis indicate the disk system is the cause of your computer problems.

4.1 PREVENTIVE MAINTENANCE

There are three areas of preventive maintenance that will be addressed. They are:

1. Cleaning the controller card and IC chip contacts.
2. Cleaning the read/write head (and checking the load pad).
3. Performing a disk speed check and adjusting if required.

4.1.1 Contact Cleaning

Use the procedures outlined in the first part of this manual (Section 2.5) to clean the controller card contacts. Cleaning the chip leads may also be necessary, but usually just pressing them into their sockets is sufficient. A very effective clue indicating the contacts need cleaning is when you turn on your "Autostart" computer and you only get the system's BASIC prompt, or the drive runs but does not boot, or booting is intermittent. In these cases TURN OFF your computer, carefully remove the disk controller card, and clean the contacts. Usually cleaning just the card contacts will return your system to normal operation.

4.1.2 Head Cleaning

How should the disk's read/write head be cleaned? This question has prompted much conversation, and numerous articles in magazines and user group newsletters. Several companies market head cleaning kits which include a cleaning fluid and a disk which resembles a standard diskette but contains a cloth-like material onto which you squirt the cleaning fluid and insert the 'diskette' into your drive. After running the drive for 30 seconds, your head is cleaned.

Head cleaning kits are expensive ($25.00 or more) and normal home computer use does not necessitate cleaning the heads more than once or twice a year. Also, the cleaning fluid may damage the load pad.

Here is an alternate procedure which seems to be effective, cheaper, and safer (if done carefully). Use a FOAM swab and Denatured Alcohol (Methanol) or Freon. DO NOT use rubbing alcohol (it contains water), and DO NOT use a cotton swab (Q-Tip). (Radio Shack has a video tape recorder cleaning kit containing six foam pads and a bottle of Freon).

1. Turn the power OFF and disconnect your disk drive from the controller card.

2. Take the drive to your workbench (somewhere away from the computer).

3. Remove the four screws on the bottom of the drive case and carefully slide the cover towards the rear of the drive to remove it.

4. Once you have the cover off, you will notice the Disk II analog board (see Figure 4.1). Unplug the read/write head connector in the right front corner of the board, remove the two screws in each front corner, gently pull the analog board forward about ¾" to free it from the plastic retaining channels and, using the connector wires at the rear edge as a hinge, lift it up and pivot it back out of the way and prop it securely.

5. You will now be able to see a metal frame which is connected to the drive door mechanism. Open and close the door a few times and notice what happens. Toward the rear of the metal frame is a device that looks somewhat like a phonograph tone arm. By lifting this "load arm" you will be able to see the read/write head underneath, and also the load pad, which is mounted in the load arm.

6. Check the load pad. Is it dirty? Does it look 'crusty'? If so replace it. (This is especially important if you use the reverse side of your disks!) To replace it, squeeze the fork-like fingers and press the load pad out of its holder (BE CAREFUL! The load arm is fragile. DON'T drop the pad on the read/write head). Then, press a new load pad into place making sure it 'snaps' into position securely. Load pads are available from your Apple dealer for about $2.50.

   Pads should be checked often enough to ensure that they are replaced before they start causing diskette damage. How often depends on drive usage, brand of diskettes used, etc., but every three months is not too often. You can tell from periodic checking how often YOU should change the load pad. Note that your boot drive may require attention more frequently due to heavier usage.

7. Now, clean the read/write head using a foam swab and the alcohol or Freon. You won't need a lot of solvent on the swab. Just dampen it. Gently swab the head, rubbing front to back. DO NOT let the load pad touch the head until all the solvent has evaporated and the head is dry!

8. Replace and reconnect the analog board, then temporarily reconnect the drive to the controller and perform a disk speed check as described below. This is more easily done now, while the cover is off, unless a hole has already been drilled for speed adjustment (see Section 4.1.4). When done, replace the screws removed in step 3 above to reassemble your disk drive.

4.1.3 Speed Test & Adjustment

The disk system is designed to operate at 300 RPM, and as long as the drive's speed remains within about 3% this value you should have little trouble reading or writing data. Occasional I/O errors may indicate a bad sector on the diskette or an out of tolerance drive speed. If you move your system a lot, the jostling that the drives encounter can alter the speed setting.

At this point you should already have the drive cover off. There are two ways to accomplish a disk speed check. One is with a software package designed for this purpose. There are several commercial and public domain utilities that will allow you to test the disk speed. The other method uses a stroboscopic technique using the strobe disc mounted on the Disk II drive pulley, as described later.

Several of the disk speed software programs have been tested, and we have found that they give differing results for drive speed. For example, one program will indicate that a drive is running fast (over 300 RPM), while another will indicate that the same drive is running slow. There is clearly some difference in the accuracy of various software methods. If you use a software speed test, you might use the stroboscopic method described below to obtain a correction factor for your software/system combination.

The second method of checking your drive's speed is a direct hardware method. To use this method you will have to remove the bottom plate of the drive housing by removing the four flat-head Phillips screws holding the bottom plate to the drive frame and releasing the plastic clamp which holds the ribbon cable to the drive case. Once this is done you will see that the drive pulley has a strobe disc similar to the kind used for speed adjustments on record players. (If your drive doesn't have a strobe disc, get one from your Apple dealer.) Using a strobe light (an ordinary fluorescent lamp will do fine) you can directly adjust the speed of the drive using the strobe disc.

If you perform the drive speed check using a software package, follow the instructions included with the software. If you use the strobe method place a scratch diskette (i.e. no important data) in the drive to be tested, so the drive motor is under a normal operating load, and turn the drive on using the following commands from monitor mode or BASIC.

MON. COMMAND	BASIC COMMAND	ACTION
C0EA	POKE -16150,0	Select Drive 1
C0EB	POKE -16149,0	Select Drive 2
C0E9	POKE -16151,0	Turn Motor ON
C0E8	POKE -16152,0	Turn Motor OFF

Illuminate the strobe disc as described above. The bars should appear to be stationary or slowly moving. Perfectly stationary bars indicate exactly 300.0 RPM. With 60 Hz. illumination a clockwise rotation of one black strobe bar per ten seconds corresponts to 300.125 RPM (.04% error). That's all there is to testing the drive's speed. If either method indicates that the drive speed is incorrect and an adjustment is needed, proceed as follows:

1. Locate the drive speed adjusting potentiometer in the lower right rear section of the drive. It is a rectangular plastic device mounted on the drive's vertical circuit card, with a brass adjusting screw in the end facing to the right side or, rarely, facing down.

2. If using the strobe test, turn the drive upside down. Turn the motor on, and while it is running, slowly turn the adjusting screw and monitor the drive speed.

3. Stop when you have the speed adjusted as close to 300 RPM as you can get it (some speed fluctuation is normal and should be expected).

4. At this point you could run your drive speed software and record its error, since you *know* the speed is 300.0 RPM). Remove the diskette, turn OFF the computer and reassemble the drive.

4.1.4 Speed Adjustment Hole

If you use a software package to adjust your drive's speed you may find it annoying to have to remove the cover to reach the adjusting screw. If your drive is out of warranty you may wish to make the following modification. This will VOID the warranty. You can drill a ¼" hole in the side of the drive housing to allow direct access to the adjusting screw. To drill the hole in the proper location proceed as follows:

1. The drive should be fully assembled at this point. On the drive's right side, measure the amount the cover overhangs the back plate. Mark off this distance on a 3 × 5 card or paper.

2. Remove the cover from the drive. Add to the distance marked above (graphically, on the card) (a) the thickness of the back panel metal, and (b) the distance from the back's inside wall to the center of the adjusting screw. This is now the horizontal distance to the screw relative to the rear edge of the case.

3. On the card, mark off the distance from the drive floor to the adjusting screw. Add (graphically) two bottom plate thicknesses. This is now the vertical distance to the screw relative to the outside bottom edge of the case.

4. Transfer the horizontal and vertical measurements to the lower right corner of the right side of the case. Mark the center of the hole.

5. Take the case to an area **well away from the disk drive and computer** for drilling! This will keep metal chips out of the system!

6. Drill the hole and remove the drilling burrs using a reamer bit or knife blade. Wipe the cover, inside and out, with a damp cloth to remove drilling chips.

7. Replace the modified cover after making SURE that all metal chips have been removed. Check that the hole lines up with the adjusting screw inside the drive.

8. To adjust the disk speed insert a regular thin blade screwdriver through the hole and adjust the pot while running disk speed test software. Adjust about monthly or before critical copying sessions.

Proper use and care of diskettes is about the only other preventive maintenance area you need to be concerned with. Don't automatically assume a hardware fault if you get an I/O ERROR. The error could just be random electrical noise or an airborne contaminant that will be removed by the wiper material inside the diskette jacket. Try to repeat the error using a scratch diskette before proceeding to major surgery.

4.2 DISK SYSTEM REPAIRS

This section covers repair of the disk drive subsystem, which includes the disk drive(s) and the controller card. A failure may stem from a known cause, such as mis-plugging the drive cable, or may be spontaneous (drive simply stops working). As a rule gradual degradation in drive performance, which can often be attributed to misalignment of the read/write head, is not repairable through chip replacement.

The repair techniques for the two circuit boards in the disk system (controller card and Disk II analog board) will be similar to those used earlier with the motherboard. However, since the number of chips on each board is small, it is generally more efficient to replace all chips, get the system working, then swap the old chips for the new (kit) chips until the system again stops working. Replace the bad chip you've found with a good one from your kit, and continue until all of the original ("old") chips have been returned to service or replaced. In this way your kit will only lose those chips required to replace chips which are actually bad. Be sure to discard the bad ones.

4.2.1 Mis-Plugged Cable

By far the most common cause of failure in disk systems is plugging the drive cable into the controller wrong, with the plug shifted one pin pair forward or backward, or shifted one entire row away from the card. In all of these cases +12 and -12 volts are applied to circuits in the Disk II which will only withstand +5 volts, so chips and other parts get blown. Rarely the controller card will also be damaged.

If this is known to be the cause of the failure, try this first (with power on/off switching at the appropriate times!): (a) Remove the case of the inoperative drive and replace (unsolder and replace) any blown (ruptured) capacitors. (b) Replace the 74LS125 chip, at location B4 on the Disk II analog board. (c) Plug the drive cable into the controller correctly and try to boot an initialized scratch diskette. If it boots, perform read, write and write protect tests. If not, follow the procedure below.

4.2.2 Drive Troubleshooting

The following drive testing is patterned after Apple's troubleshooting procedure which uses a known good set of components (drive and controller card) to help isolate a problem. It is highly recommended that you get together with a friend and use the substitution procedure; it will save a LOT of time. If you can't do substitution it may not be possible for you to positively isolate the problem.

The following also assumes that the computer works with the controller card removed, but the drive does not work. (If the computer doesn't work after a cable plugging "accident", even with the drive controller card removed, motherboard repair (Section 3) will be required before you proceed).

The failure symptoms are often useful in diagnosing the problem.For example, four situations are often encountered, as follows. In each situation it is assumed that the computer works with the controller card removed. For further detail see the disk and controller circuit schematics, pages 145, 146 of the DOS 3.3 Manual, and the motherboard schematic, page 110 of the Apple II Reference Manual. Chip locations for the drive analog board and the controller card are shown on Figures 4.1 and 4.5 respectively.

a. Computer does not run with the controller card installed (with or without drive attached). Analysis: data and/or address busses may be jammed due to bad chip(s). Suspect controller card chips D3 (P5A PROM), C3 (74LS323), C2 (74LS259), or motherboard chips H2 or H12 (74LS138).

b. Nothing happens when a PR#6 command is issued (motor does not run). This could be the controller, drive, or both. There is insufficient information to draw any conclusions. Use the flowcharts to isolate the cause.

c. A PR#6 causes the motor to run, but the head does not home or seek, and the system does not boot. Suspect all controller card chips, and drive analog board chip D4 (ULN2003).

d. A PR#6 causes the motor to run and head to home, but no boot. Suspect drive analog board chip B1 (MC3470), the read/write head, or a head placement (mechanical) problem.

The following troubleshooting flowcharts apply for all of the above failure conditions. As stated above, substitution is a most effective troubleshooting method, and is highly recommended. Availability of both a known-good spare controller card and disk drive allow a rapid, unambiguous determination of the failed item. Usually, however, only a spare drive is available. (It is considered quite unlikely for both drives in a two drive system to go out at the same instant. The second drive can usually be considered to be good and used for testing.) If neither a spare card nor drive is available, it may not be possible to determine the bad component if the system doesn't "come up" when chips are replaced. Due to the differences in the procedures for each of these main cases, separate flowcharts have been prepared for each case, as follows. Only one flowchart will apply to your particular situation.

4.2.2.1 Troubleshooting With Spare Controller and Drive (Case 1)

This procedure uses substitution of a known good controller card and known good drive to indicate whether a "drive failure" is due to your "suspect" controller card, drive, or both. The following discussion refers to the flowchart boxes on Figure 4.2. Proper switching of the computer's power is implied in all of the following operations. TURN OFF THE POWER before each remove/replace operation!

FIGURE 4.2:
Boxes 1-3. These steps assure that the computer is working properly with the controller card removed. RESET (or CTRL-RESET) should return the system prompt, and the computer should behave normally. If not, repair the main system (see Section 3).

Boxes 4 & 5. Proper computer operation will be further verified by running the system with known-good controller card and drive. If

it fails at this point, a motherboard chip which drives Slot 6 (chips H2, H12) is probably bad. Boot a known-good diskette which contains DOS, but no valuable files (i.e. a scratch diskette).

Boxes 6 & 7. In this step the known-good controller and "suspect" drive are tried together. If the test fails, the drive is bad and must be repaired. If it succeeds, the controller card is bad.

Box 8. Replace all disk drive analog board chips (see Figure 4.1) from your Drive/Controller kit. Be especially careful with the MC3470 read amplifier chip; it is sensitive to static electricity and expensive.

Box 9 & 10. If the drive still does not work, even with all new chips, you could either perform additional analysis, such as checking other components, circuit board traces, connectors, cable, etc., or take the drive to a dealer for service.

Box 11. If the drive works, you must determine if the controller card is also bad. Install the "suspect" controller with the repaired drive and boot.

Box 12. If the system boots, the controller card is OK. If not, the controller card must be repaired by going to the procedure at Box 14.

Box 13. At this point the controller and drive are OK. Swap old and new chips in the drive (as explained in 4.2) until the bad chips are identified, and replace the bad chips. This completes the repair.

Box 14. This branch is taken if the "suspect" drive works with the known-good controller card, or the "suspect" controller card does not work with a good drive, indicating that your "suspect" controller card is bad. Replace all of the controller card chips (see Figure 4.5) provided in your chip kit. Note that PROMs P5A and P6A are not supplied, since they contain copyrighted Apple firmware.

Boxes 15 & 16. In this step your drive (which tested good) is operated with the "suspect" controller card. If the boot is successful, the chip replacement repaired the controller card.

Box 17. If the boot is not successful, the fault could be components other than chips, broken traces, etc., or bad Apple PROMs. In this case you might go back to Box 13 and install PROMs P5A and P6A from the know-good controller card. If it still doesn't work, you can be reasonably sure it's not a chip problem, and dealer service is required.

Box 18. If the system works, return the "old" chips which are good to the controller card by the one-by-one substitution method. This completes the repair.

4.2.2.2 Troubleshooting With Spare Drive Only (Case 2)

This procedure uses a spare drive to help isolate the problem to the "suspect" drive or "suspect" controller card. The following refers to Figure 4.3. Proper power on/off switching is implied!

FIGURE 4.3:
Boxes 1-3. These steps assure that the computer is working properly with the controller card removed. RESET (or CTRL-RESET) should return the system prompt, and the computer should behave normally. If not, repair the main system (see Section 3).

Boxes 4 & 5. In this step a know-good drive and "suspect" controller card are tried together. If the test fails, the controller card is bad. If it succeeds, the "suspect" drive is bad.

Boxes 6 & 7. Replace all of the disk drive analog board chips (see Figure 4.1) from your chip kit. Be especially careful with the static-sensitive MC3470! Try to boot the system.

Box 8. If the drive still fails to boot, either perform additional (non-chip) diagnosis or get dealer service on the DiskII.

Box 9. If the drive works, swap old and new chips and replace the bad chips. This completes the repair.

Box 10. This branch is taken if the controller card is bad. Replace all controller card chips provided in your kit. Apple PROMs are not provided.

Boxes 11 & 12. If the boot fails, the controller card is still bad and requires further analysis or dealer service. The PROMs could be the problem, but without spares, you can't tell.

Box 13. If the boot succeeds, the repaired controller card is working with the known-good drive. Now substitute the "suspect" drive to see if it was also "blown".

Box 14. If the boot fails, the "suspect" drive is also bad. Repair it by starting at Box 6.

Box 15. If the boot succeeds, the drive is OK. Swap the old and new chips in the repaired controller card and discard the bad chip(s). This completes the repair.

4.2.2.3 Troubleshooting With No Spares (Case 3)

Since no spare drive or controller card is available for substitution, this procedure uses brute-force substitution of chips. It may be impossible to resolve whether the drive, controller card, or both are bad. The following refers to Figure 4.4. Proper power on/off switching is implied!

FIGURE 4.4

Boxes 1-3. These steps assure that the computer is working properly with the controller card removed. RESET (or CTRL-RESET) should return the system prompt, and the computer should behave normally.

Box 4. Replace the chips in both the drive and the controller card (except Apple PROMs on the controller, which are not supplied).

Boxes 5-7. Try to boot the system. If it fails to boot, the problem cannot be resolved by drive system chip substitution. It could be a motherboard problem (esp. chip H2 or H12), or a non-chip problem on the drive or controller. Dealer service is required.

Box 8. If the boot succeeeds, swap the old and new chips one-by-one, first the drive and then the controller, and replace all found to be bad from your Disk/Controller chip kit. This completes the repair.

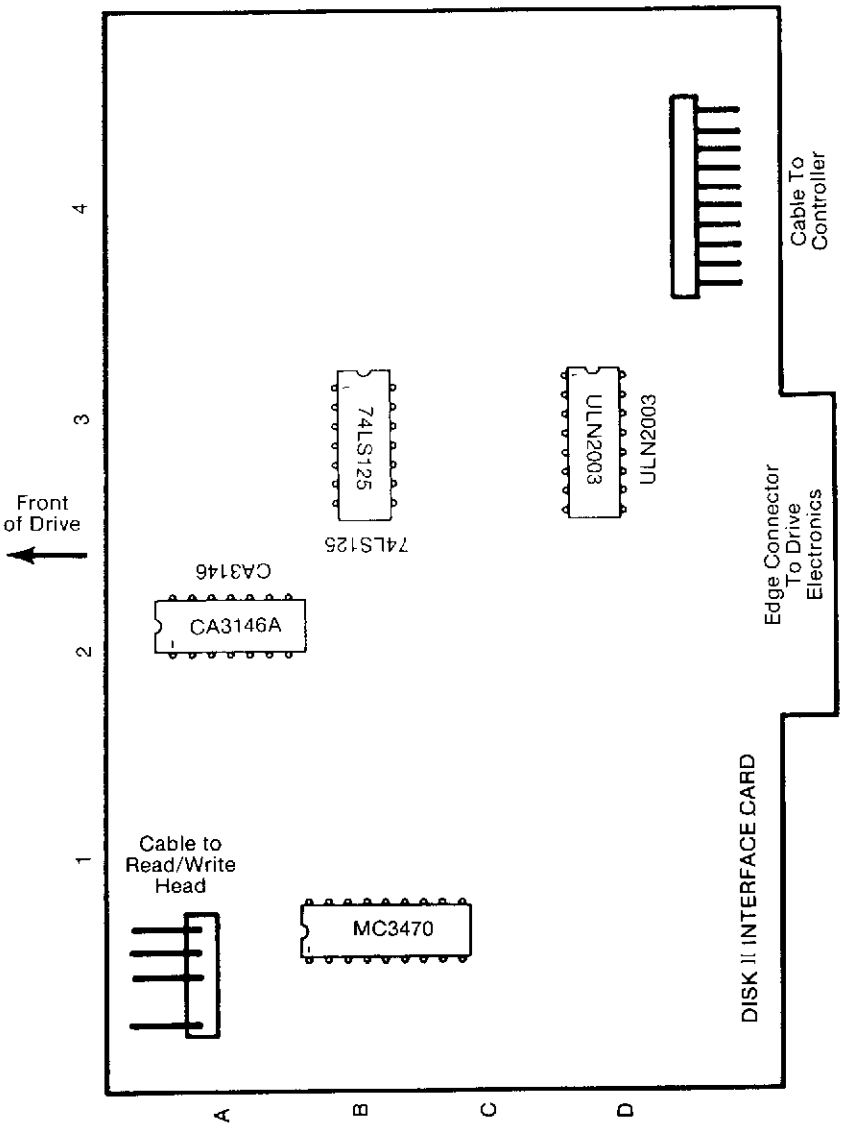


Figure 4.1
Disk II Analog Board

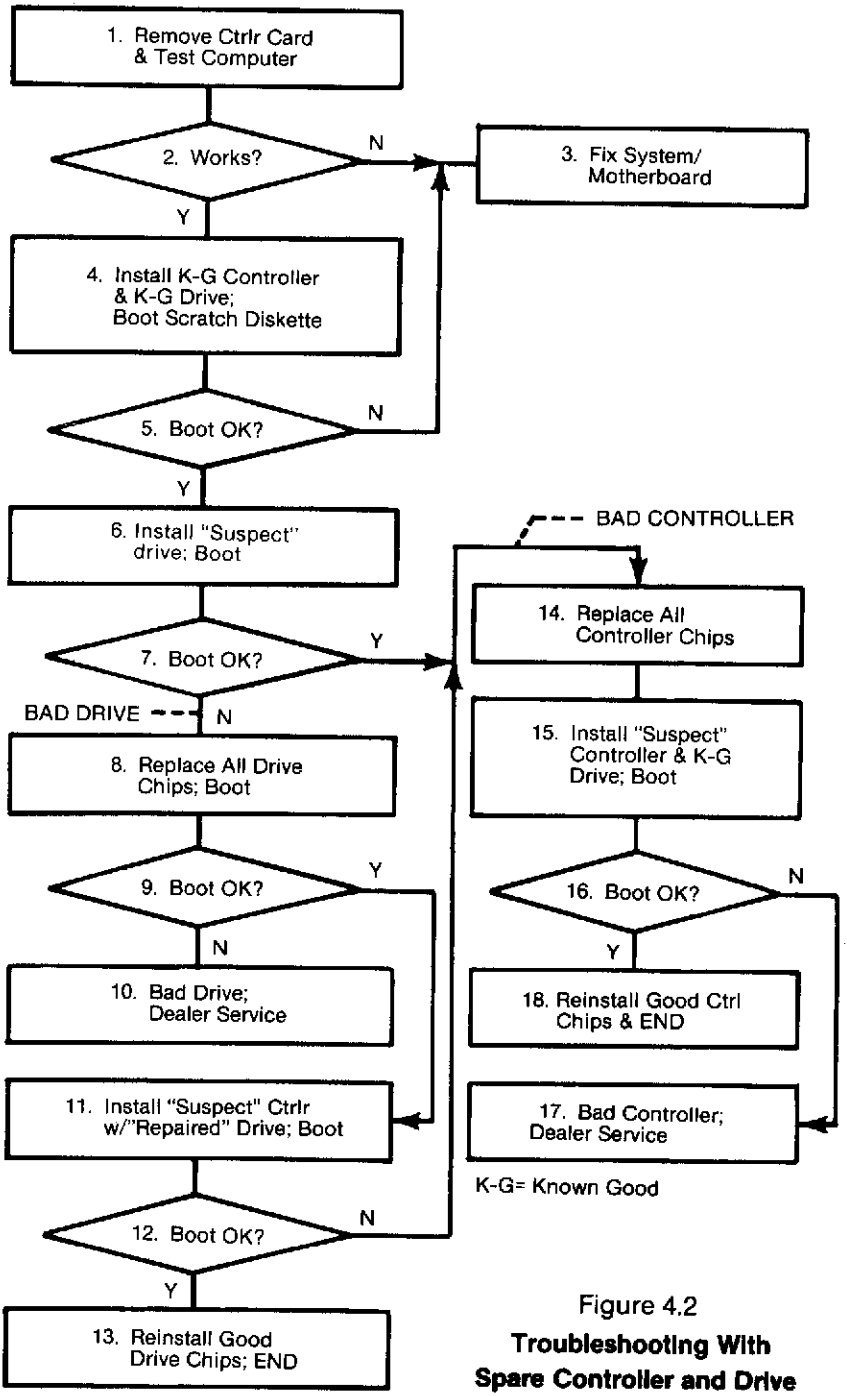


Figure 4.2
Troubleshooting With Spare Controller and Drive

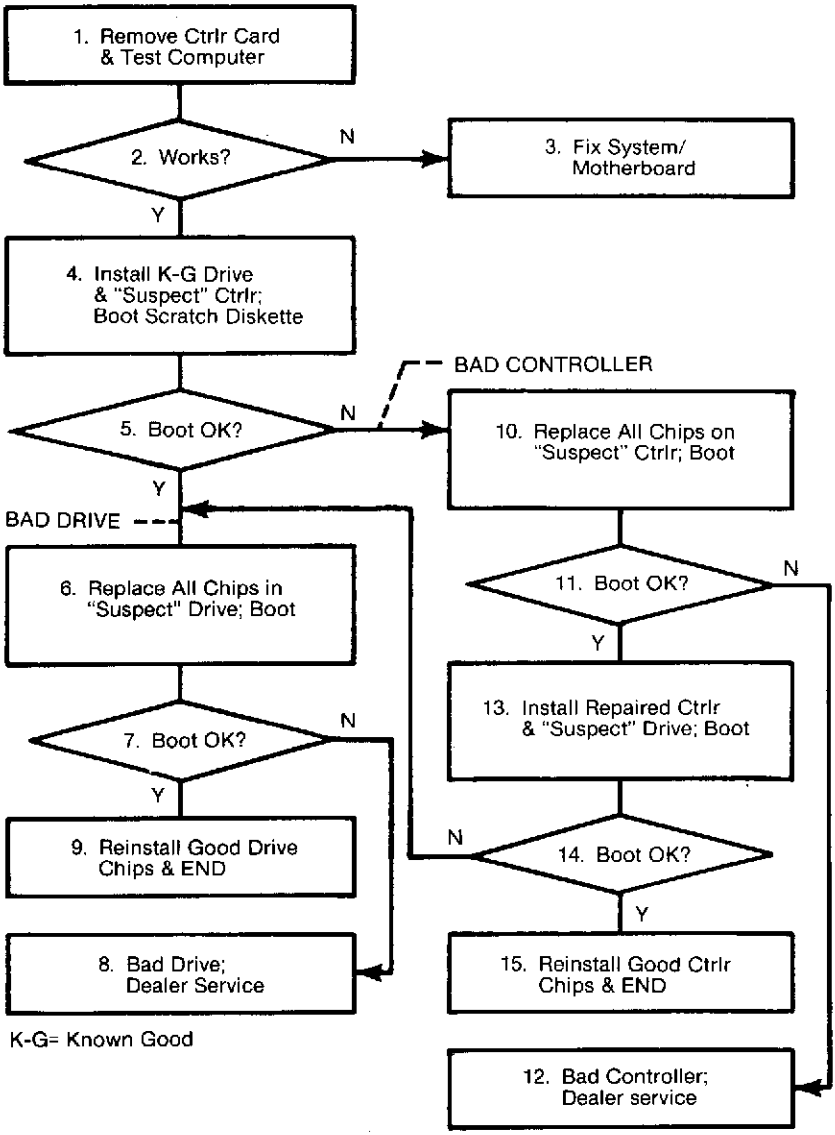


Figure 4.3

Troubleshooting With Spare Drive Only

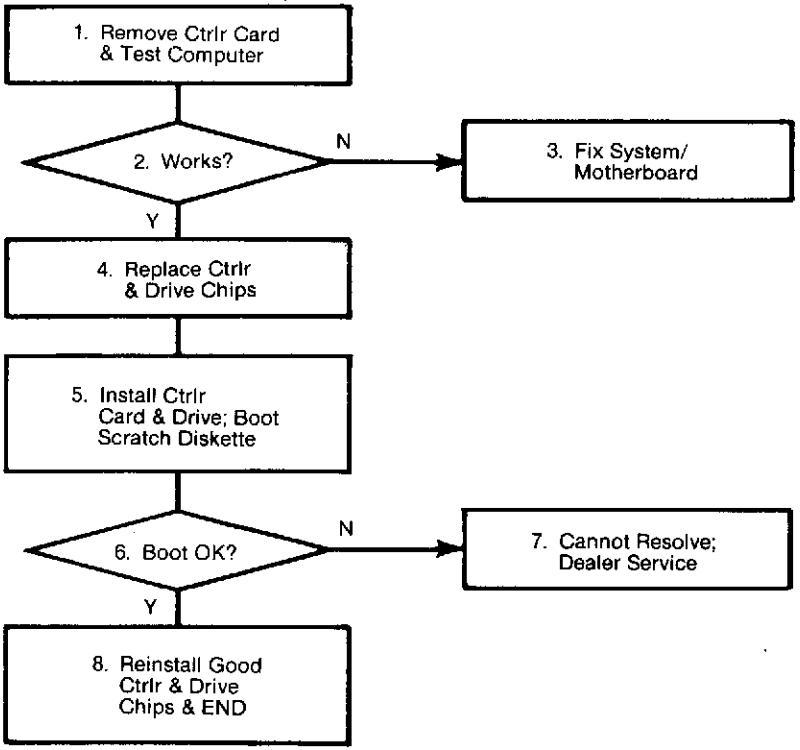


Figure 4.4
Troubleshooting With No Spares

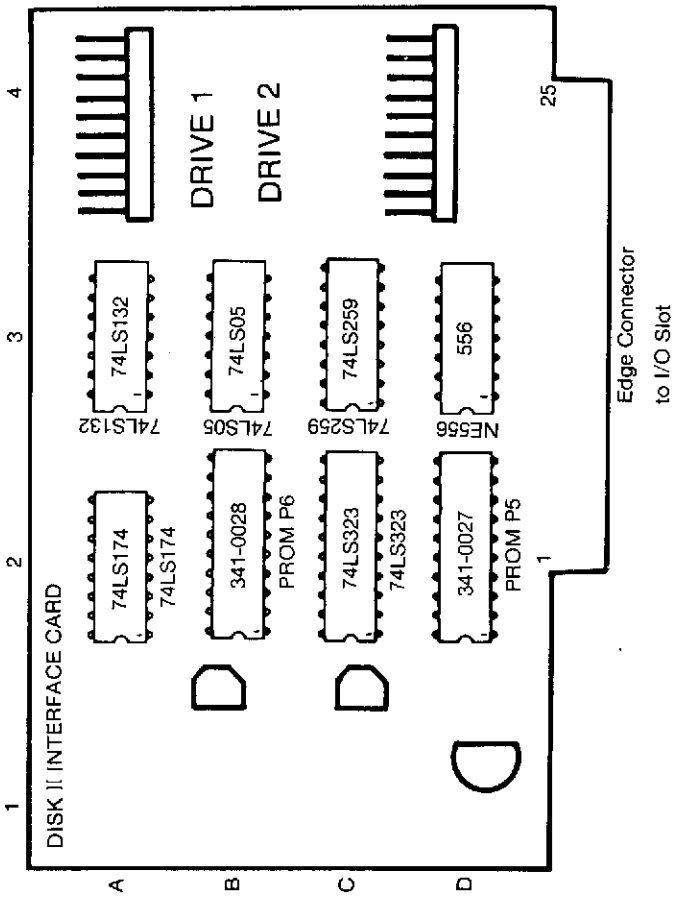


Figure 4.5
Disk II Controller Card

5.0 EXAMPLES

What follows are some examples of situations that have been encountered. In some cases the *AppleChips* Kits solved the problem, and in some cases additional troubleshooting was required. (Unless you have an electronics background, this additional troubleshooting would normally be done by your dealer. These cases are presented to show an interesting range of problems.) The symptoms, analysis and cure will be discussed for each case.

5.1 Case One:

Symptom: The computer would not RESET. When turned on the screen would fill with trash and all would stop. The only three cards in the computer at the time were a 16K RAM card, a D.C. Hayes Micromodem II, and the Disk Controller.

Analysis: By following the step-by-step procedures in the first two parts of this manual the trouble was found to exist whenever the modem and the disk controller were installed together (it didn't matter which slots each were in). The disk controller operated normally when the modem was removed. The modem operated normally when the disk controller was removed. Possible source of problem - address bus conflict.

Cure: After checking the Disk II Interface (controller card) schematic on page 145 of the DOS 3.3 manual, chip C2, IC type 9334 (or 74LS259) was replaced. This is one of three chips which are connected to the system bus (C2, C3, and ROM P5), so it was a logical choice. A system check was accomplished and all was determined to be in proper working order.

5.2 Case Two:

Symptom: After transporting and reconnecting the system the disk drive was completely inoperative. The operator heard a 'pop' just after turning on the computer and noticed a 'burned smell'.

Analysis: The controller card was installed in another computer and it operated normally with the other computer's drive. Next, the drive cover was removed and the analog board examined. The large chip (MC3470) at B1 was blistered and cracked and there was a smoke stain on the roof of the cover. This chip is the read amplifier and is one of the most expensive chips in the system at nearly $10.00.

Cure: Replace the MC3470 chip and check out. Although the actual cause will never be known, a very probable cause was incorrect connection of the 20-pin flat cable to the controller card. (Note:

A very careful examination of the controller card/drive cable connection would have revealed a misconnection if present. Check carefully before unplugging anything!) If the cable is connected just one row of pins off, -12 volts will be sent down the line which uses only +5 volts (pins 9 and 11 in schematic on page 146 of DOS Manual). BE CAREFUL WHEN RECONNECTING YOUR EQUIPMENT.

5.3 Case Three:

Symptom: The computer would not boot when turned on. No RESET. No heartwarming 'BEEP'.

Analysis: Using the established troubleshooting procedures, the disk controller card was found to be the culprit. Because the system was not RESETing, chip replacement began with the 556 quad timer chip at location D2. This chip was selected as it was directly connected to the RESET line on peripheral connector pin 31. (Refer to the Disk II Interface (controller card) circuit diagram on page 145 of the DOS 3.3 manual.) Replacement of this chip did not solve the problem. Each chip on the card was replaced one at a time and the system rechecked. The problem still existed. A different controller card was installed and the system worked fine. All chips from the defective card were installed on the second controller card and that combination worked fine. Now what? The now unpopulated (no chips installed) controller card was examined for solder bridges, bad contacts, and broken traces. Nothing. Still concentrating on the RESET circuitry around chip 556 an ohmmeter check was made of each electrical component (resistors, capacitors, etc.). The capacitor at location C1 was found to be defective (did not read infinite resistance).

Cure: Capacitor C1 was replaced and the controller card, with its original set of chips, returned to normal operation.

5.4 Case Four:

Symptoms: While attempting to install a peripheral card in slot number 1, the operator forgot to turn off the power. By the time he saw the spark, it was too late. Now the computer would not respond. Turning off the power and then turning it back on would not boot the disk drive. There was no RESET and no 'BEEP'.

Analysis: At the time of the improper installation there were two cards already installed in the computer. A disk controller card in slot 6 and a ROMPLUS card in slot 5. The card that was being plugged in became the suspect card. However the symptoms did not clear up with removal of the suspect card. The next step was to remove the

ROMPLUS card. At this point the only card remaining in the computer was the disk controller card. When the computer was turned on the disk drive booted normally, indicating that the card that was in slot 5, the ROMPLUS, was the culprit. The computer was turned off and the original card was inserted into slot 1 (this time with the power OFF). Again, the computer acted normally, thus eliminating both the disk controller card and the one in slot 1. The chips were removed, one at a time, from the suspect ROMPLUS card and a system check was performed. Finally, when the defective chip was removed (leaving an empty IC socket on the card), the disk drive again booted.

Cure: The chip that was removed was replaced and the card worked normally. Note: The peripheral card that was damaged was NOT the one that was improperly installed.

5.5 Case Five:

Symptoms: The disk drive would boot and operate normally, however, the drive motor would continuously run.

Analysis: The drive would display the same symptoms whether it was used as drive 1 or drive 2, thus directing our attention to the disk drive and not the controller card. By referring to the Disk][Analog Board schematic on page 146 of the DOS 3.3 Manual it was determined that one of the pins on the analog board was labelled 'MTR ON'. This line was traced back to pin 14 of the drive cable connector which was labelled 'ENABLE'. Swapping chips with a known good analog card did not produce any improvement. All chips were removed from both the known good and the suspect analog cards. An ohmmeter was used to compare the two analog cards at various points. The first guess (at pin 14) proved to be correct as the suspect card showed an open circuit between input (cable pin 14) and output (card contact K). The suspect card had been checked earlier for broken leads, etc. but looked fine. Upon closer inspection, using a magnifying glass, it was discovered that the circuit board was defective since manufacture. One of the traces on the board was broken in a way that it would sometimes make contact. The problem was complicated by the fact that the broken trace was underneath one of the IC sockets and was not visible with the chip installed.

Cure: The broken trace was repaired by using a short jumper wire soldered to pin 14 and to the trace on the opposite side of the IC socket, thus bypassing the break.

Comment: This case shows that the *ChipKits* are not a cure-all, and some repairs require test equipment and electronics skills. However, a great many system failures are the result of single chip failures, and can be repaired easily and quickly using *ChipKits*.

6.0 HANDLING INTEGRATED CIRCUIT CHIPS

The integrated circuits used in the Apple are reasonably rugged and easy to remove and replace if care and common sense are used. Two of the most common problem areas in self-repair are chip and/or system damage due to static electricity discharge, and mechanical or electrical damage to chips due to mishandling or mis-plugging. The problems and solutions are described below.

6.1 STATIC ELECTRICITY PRECAUTIONS

In troubleshooting your Apple by removing and replacing integrated circuits, you should be aware that integrated circuits are susceptible to damage (destruction) from static electricity discharge. Some types, such as those made using a Metal-Oxide-Semiconductor (MOS) process (such as the 6502 microprocessor and the 4116 memory chips) are quite sensitive to static discharge. Others, such as linear circuits (555 timers, MC3470 read amplifier in the Disk II), are moderately sensitive. The other logic (TTL process) are relatively insensitive, but can be damaged.

Chips are usually "blown" when you build up a static charge on your body, by walking across a carpet, or even moving in a plastic-covered chair, and then touching the leads of a chip. The rule to remember is PREVENT STATIC CHARGE BUILDUP ON YOURSELF, THE CHIPS AND THE SYSTEM WHILE YOU ARE HANDLING CHIPS! By taking a few simple precautions you can prevent static damage to your chips.

1. Make sure that the system power is OFF before removing or replacing chips. Pulling chips with the power on is every bit as damaging as static electricity!

2. Keep the system grounded while working on it. Either keep the power cord plugged into the system and wall socket (but with the power switch OFF!), or run a separate wire from the outlet ground ("third wire") to the power supply case. (Note that the power cord third wire, the power supply case, and the computer bottom plate are connected together electrically. However, this "case ground" is NOT connected to the motherboard's circuit ground, which is accessable, for example, on the outer contact of the video output jack.)

3. Handle chips by their plastic bodies, not their pins. If you must touch the pins, as when squeezing the pin rows together to make them fit into a socket, be SURE you've discharged yourself first!

4. DO NOT place integrated circuits in or on plastic (unless it is specially formulated "conductive plastic", such as that used for the carrier of your *ChipKits*). A damaging static charge can build up easily on good insulators.

5. For maximum protection, keep yourself grounded while handling chips. To do this you could, for example, connect yourself to ground using several feet of light, flexible (stranded) hookup wire. One end of the wire could be connected to a metal watch band on your wrist, and the other end connected to the computer bottom plate THROUGH A 100,000 Ohm OR LARGER RESISTOR, NOT DIRECTLY. Of course, the computer will have to be grounded, as described in 2. above. Wire, resistor and small alligator clips are available from Radio Shack and other parts houses. Unless you're in a high static situation, e.g. low humidity and wool rug, periodically touching the power supply case will probably suffice.

6. If you frequently work on your system in a high-static situation, you may wish to purchase a conductive workbench cover, with grounding cable and wrist strap. A cloth one is available from Wescorp; see Section 8.

7. If you have occasion to do soldering on your system, ground the tip of the soldering iron to the outlet "third wire" through a 100,000 ohm to 1 Megohm resistor.

8. If your system has a high failure rate, you may be causing it through static discharges. Drawing a spark when you touch the bottom plate usually just causes a glitch, but could possibly cause chip damage. A much more serious problem is drawing a spark to the disk drive case, which is often not well grounded. A possible solution is to install a conductive surface (metal plate) near or under the computer and wire it separately to the outlet "third wire" ground. Then, always touch this plate before touching any parts of the system. You may get a static shock, but should't blow chips.

6.2 HANDLING PRECAUTIONS

Chips and peripheral boards must be removed and inserted with care to avoid mechanical damage. Always check that the POWER IS OFF before working with chips or cards!

Chips should be removed by inserting the prongs of the chip puller under the ends of the IC package and gently rocking the chip end-to-end while pulling upward. The 6502 chip is so large that you may have to pry it out by alternately inserting the blade of a small

screwdriver under the ends. Pulled chips should be immediately stuck into a conductive plastic foam pad to help protect them from static discharge.

To reinsert chips, place the chip pins in the socket's contact holes, and assure that everything is lined up properly, i.e. the pins are not shifted forward or backward by one row, the pin rows are the proper width, and the notch (pin 1 key) is facing the right way. For new chips, you will probably have to squeeze the pin rows together to get the correct row-to-row spacing. To insert, apply pressure to both ends of the top of the chip simultaneously, alternately applying more pressure to one end, then the other, until the chip slips into the socket. When installing chips, USE A BRIGHT LIGHT so that you can see exactly what's happening, and work slowly and carefully. If it doesn't go in smoothly, stop and check the chip. It's quite easy to fold a pin under the package, and tough to find afterwards.

Similar rules apply to removing and inserting peripheral cards. To remove a card, rock it front-to-back while pulling up gently. To reinsert, place the back corner of the card-edge connector against the solid back end of the connector shell, then rotate the front edge down until the card edge is parallel to the connector top, and push down firmly.

7.0 RAM MEMORY TESTING

A 48K Apple II has 24 RAM chips, but the motherboard kit only contains two replacement RAM chips. How do you find a bad RAM chip? If you own a commercial diagnostic program, it probably contains a RAM test routine. If not, you can use the one you already own, but may not know about, as described below.

This section presents a technique for testing RAM memory using a "hidden" memory test routine in the 'INTBASIC' Integer BASIC binary file supplied on your Apple DOS 3.3 system Master diskette. The procedure you use will depend on the type and configuration of your system.

There are two versions of the procedure. Case 1 is for 64K Apple II Plus computers (with a 16K memory extension or "language" card). Case 2 is for 48K Apple II Plus (no 16K card) and Apple II (Integer BASIC) computers. Note that when the test is stopped you must reboot the system, as DOS will have been overwritten. Proper use of the RETURN key after each entry is implied. Note the difference between a zero (0) and the letter O below

7.1 Case 1 - Apple II Plus with RAM Card

A. Boot the DOS 3.3 System Master
This will install the Integer BASIC language, "old" monitor, and Programmer's Aid ($D000-$DFFF) code, from the INTBASIC binary file, in the 16K card memory.

B. Type INT
This switches from Applesoft to Integer BASIC (> prompt).

C. Type CALL -151
This switches to the old monitor image stored in the 16K card (* prompt).

D. From monitor (*), type 36:F0 FD 1B FD
This changes four hex bytes at location $36, to disconnect DOS so your system won't "hang" when the DOS area is overwritten by the RAM test. Type this exactly as shown, with the spaces between bytes. To check this, type 36.39 and compare the four bytes displayed with the above.

E. From monitor (*), type D5BCG
This sets up the entry routine for your later inputs which specify the area of memory you want tested. The monitor prompt should appear, two lines down, with no beeps or other outputs. If it doesn't, check the code at $D5BC against the listing below to make sure that you have the Programmer's Aid code in

memory. Type D5BCL and compare the first seven lines with the following partial listing. If, for some reason, you can't get INTBASIC into your 16K card, use the procedure for non-16K systems in Section 7.2 below.

```
D5BC-  A9  C3      LDA  #$C3
D5BE-  A0  D5      LDY  #$D5
D5C0-  4C  B0  D5  JMP  $D5B0
D5C3-  A9  00      LDA  #$00
D5C5-  20  D0  D5  JSR  $D5D0
D5C8-  A9  FF      LDA  #$FF
D5CA-  20  D0  D5  JSR  $D5D0
```

F. You may make one pass through memory, or automatically repeat the test indefinitely (until RESET). You may also test specific memory ranges. Step G describes a single pass through all memory (above $3FF), Step H describes a repeating test, and Section I, Discussion, describes what is happening.

G. One pass through memory
After successfully completing Step E above, type the following (from monitor) exactly as shown (no spaces!). The CTRL-Y does not print to the screen, so the numbers will appear to run together; this is normal. **Do not** type the spaces before and after the CTRL-Y commands! They are for clarity only. The RETURN starts the test. See Step I, Discussion, below.

400.4 CTRL-Y 800.8 CTRL-Y 1000.10 CTRL-Y 2000.20 CTRL-Y 3000.20 CTRL-Y 4000.40 CTRL-Y 7000.20 CTRL-Y 8000.40 CTRL-Y RETURN

H. Continuous passes through memory
After Step E above, type the following (from monitor) exactly as shown. **DO NOT** type the spaces before and after the CTRYL-Y, but you **MUST** type ONE space before the RETURN). The RETURN starts the test, and it runs until stopped by RESET.

N400.4 CTRL-Y 800.8 CTRL-Y 1000.10 CTRL-Y 2000.20 CTRL-Y 3000.20 CTRL-Y 4000.40 CTRL-Y 7000.20 CTRL-Y 8000.40 CTRL-Y 34:0 RETURN

I. Discussion

The numbers above, in the form a.p CTRL-Y, are specifying a range of memory to be tested. The number a is the hex starting address, and the number p is the range, in hundreds of hex bytes, e.g. 400.4 CTRL-Y specifies the range $400 through $7FF (pages $4,5,6, and 7). The test is broken into ranges because the test length $p*100 must not be greater than the starting address A.

The first range, 400.4 ($400 - $7FF) will garbage the screen, first with inverse @ symbols, then ? symbols, so you can easily tell if the test is running. After each subtest is completed (i.e. at each CTRL-Y) you will hear a beep, but nothing is printed to the screen unless an error is found. The subtests 400.4 through 2000.20 tests the first 16K row of memory (Row C), 4000.40 tests the second row (Row D), and 8000.40 tests the third row (Row D). The tests of 3000.20 and 7000.20 are special tests of the row boundaries and should not be omitted.

7.2 Case 2 - Apple][Plus 48K (no RAM card) and Apple][(Integer)

In this case there is no 16K RAM card for storing the test code, so you must load the test routine from the INTBASIC file into your on-board RAM, make a few modifications to it (i.e. modify it to run at $2BC rather than at $D5BC), and store it on disk for future use. Perform the steps listed below. Note that an Apple][with 16K card can use the Case 1 procedure if you can get INTBASIC loaded into your 16K card (DOS automatically loads Applesoft; loading INT requires some tricks beyond the scope of this section). Also, if you have an Apple][with a Programmer's Aid ROM, follow the instructions in the Programmer's Aid manual.

A. Boot the DOS 3.3 System Master diskette.

B. Type BLOAD INTBASIC,A$4000.

C. Type CALL-151.

D. From monitor (*), type 2B0 < 45B0.4691M.
This moves the 226 bytes of test code to start at $2B0.

E. Type all of the following exactly as shown. They change the test code so it will run in the $2B0-$391 area. RETURN after each entry is implied

2BF:2	2C2:2	2C7:2	2CC:2	305:3
30A:3	30E:3	327:3	32C:3	367:3
36E:3	372:3	37C:3	381:3	

F. Type 3D0G
This returns you to Applesoft.

G. Place a non-write protected diskette to receive the file in the drive, and type BSAVE INTBASIC RAM TEST,A$2B0, L$E2 .
This saves the modified test code to your diskette.

H. To use on a 48K Apple, boot the system and type BLOAD INTBASIC RAM TEST.

I. Type CALL -151.

J. From monitor (*) type 36:F0 FD 1B FD.

K. From monitor type 2BCG to set up the test.

L. To initiate a test, use either the one pass or continuous test procedures from Steps 7.1G or 7.1H above.

7.3 Tests Performed and Screen Displays

The test program performs two types of tests, simple and dynamic.

The simple test writes a number to memory and then checks that it reads back correctly. Simple errors are reported to the screen in the following format: xxxx yy zz ERR r-c, where xxxx is the hex address at which the error was detected, yy is the hex data byte written, zz is the hex data byte read, r and c are the (alphabetic) row and (decimal) column where the defective chip was found. Counting from the left, the RAM occupies columns 3 through 10 (decimal). An example of output might be: 201F 00 10 ERR D-7.

The dynamic test checks the contents of all addresses which differ from the test address by one bit for changes in their contents. A dynamic failure is thus one in which the act of writing a number to one memory location causes the number read from another location to change. Dynamic errors are reported to the screen in the following format: xxxx yy zz vvvv qq ERR r-c. In this case xxxx is the hex address at which the error was detected, yy is the hex data written earlier to the address, zz is the hex data read back from xxxx, vvvv is the current (test) address, qq is the data successfully written to and read from vvvv, and r-c are row and column. In this test the reported column is correct, but the row may not be. If a dynamic error occurs, run subtests which check only one row to find the bad chip. An example of output might be: 5051 00 08 5451 00 ERR E-6.

If you think you are having memory problems, use the continuous test, and run it for 24 hours or more, with the lid on, to allow the memory chips to reach maximum operating temperature.

To double check memory chips on your 16K memory board, swap them with row E chips and rerun the memory test segment for row E only, as follows: N7000.20 CTRL-Y 8000.40 CTRL-Y 34:0 RETURN.

★★★★ NOTE ★★★★ Memory chips are the most static electricity sensitive chips in your Apple. If you must change them, MAKE SURE to observe the handling precautions described in Section 6 of this manual!

This procedure is based on an article "A RAM MEMORY TEST" by Fred Perkins, *"Bits and Bytes"*, Vol. 5. No. 2, Mar-Apr 1983, pp. 14-17, Apple Computer Enjoyment Society of Southern Florida, Coral Springs, FL, and on the Apple booklet *"Programmer's Aid #1 Installation and Operating Manual"*.

8.0 REFERENCE DATA

This section presents technical reference data, books, chip sources, and other information useful in maintaining and servicing Apple systems.

8.1 CHIP LOCATION INDEX

The Apple II motherboard uses a matrix indexing scheme to specify the location of each chip, i.e. rows A through K (less rows I and G, which were omitted to avoid confusion with the numbers 1 and 6), and columns 1 through 14. These matrix labels are printed along the bottom and left edges of the motherboard. Figures 8.1 through 8.3 present cross-indexes for mapping motherboard location to chip type and vice versa. The Disk II and Controller boards are similarly mapped. See the figures in Section 4).

Figure 8.1 - Motherboard IC Index, by Location
Sequential list of motherboard locations, with corresponding chip types.

Figure 8.2 - Motherboard IC Index, by Chip Type (Logic Funct)
Sequential list of chip types, with corresponding motherboard locations and chip logic function.

Figure 8.3 - Motherboard IC Index, by Chip Type (System Funct)
Sequential list of chip types, with corresponding motherboard locations and (abbreviated) system function(s) performed by the chip.

8.2 REFERENCE BOOKS

The following reference books have been found to be useful in understanding and servicing the Apple II.

1. Apple II Reference Manual
2. Apple II DOS 3.3 Reference Manual, Apple Product #A2L0036
3. Apple II Programmer's Aid #1 Installation and Operating Manual, Apple Product #A2L0011
4. The Apple II Circuit Description, by W.D. Gayler
   Howard W. Sams & Co.
   4300 West 62nd St.
   Indianapolis, IN 46268

5. *DON'T (or how to care for your computer)*, by Rodnay Zaks
   Sybex
   2344 Sixth St.
   Berkeley, CA 94710

6. *TTL Data Manual*
   Many Sources:
   (TI, Signetics, National, Motorola, Fairchild, etc.).

8.3 REPLACEMENT CHIPS/PARTS SOURCES

At this time Apple-Dayton does not offer replacements for individual ICs, but may sell replacement chips in the future if customer feedback indicates a need for this service. Once chips have been used from your kit(s), they should be promptly replaced by ordering from an electronic parts distributor or a mail order electronics company. The following listing of mail order companies is provided FOR INFORMATION ONLY. THE LISTING DOES NOT REPRESENT ANY INDORSEMENT BY APPLE-DAYTON. The listing is alphabetical order; order does not imply differences in quality or service.

Active Electronics
P.O. Box 1035
Framingham, MA 01701
(800) 343-0874

Advanced Computer Products
1310 E. Edinger
Santa Ana, CA 92705
(800) 854-8230

Digi-Key Corporation
P.O. Box 677
Thief River Falls, MN 56701
(800) 346-5144

Do Kay Computer Products Inc.
3250 Keller St. #9
Santa Clara, CA 95050
(800) 538-8800

Electrolabs
P.O. Box 6721
Stanford, CA 94305

Jade Computer Products
4901 W. Rosecrans Ave.
Hawthorne, CA 90250
(800) 421-5500

Jameco Electronics
1355 Shoreway Road
Belmont, CA 94002
(415) 594-8097

JDR Microdevices
1224 S. Bascom Ave.
San Jose, CA 95128
(800) 538-5000

Priority One Electronics
16723C Roscoe Blvd.
Sepulveda, CA 91343
(800) 423-5633

8.4 CHIP MARKING CONVENTIONS

In this section we describe the marking and numbering conventions used on IC chips so that you can get the right chip in the right socket, facing the right direction. Figure 8.4 shows the outlines of "standard" IC packages, but even these will vary somewhat in minor details, such as the size and location of mold marks on the package top. Refer to Figure 8.4 while reviewing the following.

The semicircular "notch" at one end of the package indicates the end nearest to pin #1. Viewed from the TOP, pin #1 is always counterclockwise from the notch, and the other pins are numbered counterclockwise from pin #1 (of course, they are clockwise if viewed from the bottom, or pins side). The notch may be a semicircle which extends through the entire thickness of the plastic package, a semicircle which extends half way, or a rectangular slot with a rounded end. On 8-pin chips there may be no slot, but only a molded dot or paint dot beside pin #1.

The important thing is to look carefully for the notch, and NOT to confuse the notch with plastic molding marks on the top surface. ICs which are plugged in backward, i.e. with the notch facing the wrong way, and powered up will almost surely be blown, as +5 volts is applied to the chip's ground terminal.

Marking can also be confusing. The writing usually reads correctly with the notch to the left, but don't count on it. Each package of a standard (non-custom) IC usually has printed on it the manufacturer's logo or name, a date code, a part number, and sometimes the country of manufacture.

The date code is usually a four digit number starting with the last two digits of the year of manufacture, such as 8217, (but again, not necessarily). Do not confuse it with the part number. The part number usually consists of a unique two letter manufacturer's prefix, a industry standard (generic) part number, and a suffix showing package type (plastic, ceramic), and sometimes a suffix showing quality level, speed (memory), or other special feature.

For example, the 74LSxxx series of ICs carries a SN prefix for Texas Instruments parts and a DM for National Semiconductor, but a SN74LS00N and a DM74LS00N are functionally the same. The N indicates a plastic package for most companies (except Fairchild uses "PC").

Linear circuits often use an A suffix to indicate higher quality (lower leakage, etc.), such as the CA3146A chip on the Disk][board. Memory chip marking is wierd, and your 4116 RAM chips may have prefixes, suffixes, or both. You must consult the manufacturer's data sheet to decode the chip speed suffix, but all should have 4116 in the number somewhere.

8.5 *ChipKits* CONTENTS

Figure 8.5 presents tables showing the total quantities of each type of chip contained on the Apple][motherboard, Disk][board, and Controller board, and the quantity of each of those chips contained in the *AppleChips* Motherboard kit (Type MK-2-1) and the Disk/Controller kit (Type DK-2-1).

Loc.	Chip Type	Loc.	Chip Type	Loc.	Chip Type
A1	—	D1	MEM SEL (2)	G	Not Present
A2	74LS00	D2	74LS20		
A3	74166	D3	4116	H1	74LS08
A4	—	D4	4116	H2	74LS138
A5	2513 (1)	D5	4116	H3	74LS367 (5)
A6	—	D6	4116	H4	74LS367 (5)
A7	KEYBOARD	D7	4116	H5	74LS367 (5)
A8	74LS257	D8	4116	H6	: 6 :
A9	74LS151	D9	4116	H7	: 5 :
A10	74LS194	D10	4116	H8	: 0 :
A11	74LS74	D11	74LS161	H9	: 2 :
A12	74LS02	D12	74LS161	H10	8T28 (3)
A13	555	D13	74LS161	H11	8T28 (3)
A14	—	D14	74LS161	H12	74LS138
				H13	558
B1	74S175	E1	MEM SEL (2)	H14	74LS251
B2	74S86	E2	74LS139 (2)		
B3	555	E3	4116	I	Not Present
B4	74LS194	E4	4116		
B5	74LS174	E5	4116	J1	74LS257
B6	74LS257	E6	4116	J2-J12	—
B7	74LS257	E7	4116	J13	74LS74
B8	74LS174	E8	4116	J14	GAME I/O
B9	74LS194	E9	4116		
B10	74LS74	E10	4116	K1-K12	—
B11	74LS08	E11	74LS153	K13	741C
B12	74LS11	E12	74LS153	K14	—
B13	74LS02	E13	74LS153		
B14	74LS02	E14	74LS283		
C1	74LS153	F1	MEM SEL (2)		
C2	74S195	F2	74LS139		
C3	4116	F3	9316B (F8)		
C4	4116	F4	—		
C5	4116	F5	9316B (F0)		
C6	4116	F6	9316B (E8)		
C7	4116	F7	—		
C8	4116	F8	9316B (E0)		
C9	4116	F9	9316B (D8)		
C10	4116	F10	—		
C11	74LS04	F11	9316B (D0)		
C12	74LS257	F12	74LS138		
C13	74LS51	F13	74LS138		
C14	74LS32	F14	74LS259 (4)		

Notes:
(1) Replaced with 2316B on Revision 7 and newer boards.
(2) Not present on Revision 7 and newer boards.
(3) Replaced with one 8304 at H11 on newer boards.
(4) Equivalent Part: 9334 = 74LS259
(5) Equivalent Part: 8T97 = 74LS367

Figure 8.1
Motherboard IC Index, by Location

Chip Type	Location	Function
74LS00	A2	Quad 2-Input NAND
74LS02	A12,B13,B14	Quad 2-Input NOR
74LS04	C11	Hex Inverter
74LS08	B11,H1	Quad 2-Input AND
74LS11	B12	Triple 3-Input AND
74LS20	D2	Dual 4-Input NAND
74LS32	C14	Quad 2-Input OR
74LS51	C13	Dual 2-Wide 2-Input AND-OR-INV
74LS74	A11,B10,J13	Dual D Pos-Edge Trig Flip-Flop
74LS138	F12,F13,H2,H12	3-To-8 Line Decoder/Demux
74LS139	E2 (1),F2	Dual 2-To-4 Line Decoder/Demux
74LS151	A9	1-Of-8 Data Selector/Mux
74LS153	C1,E11,E12,E13	Dual 1-Of-4 Data Selector/Mux
74LS161	D11,D12,D13,D14	Binary Counter w/ Direct Clear
74LS174	B5,B8	Hex D Flip-Flop
74LS194	A10,B4,B9	4-Bit Bidirectional SR
74LS251	H14	1-Of-8 Data Selector/Mux (3-St)
74LS257	A8,B6,B7,C12,J1	Quad 1-Of-2 Data Sel/Mux (3-St)
74LS259 (2)	F14	8-Bit Addressable Latch
74LS283	E14	4-Bit Full Adder w/ Look Ahead
74S86	B2	Quad 2-Input XOR
74S175	B1	Quad D Flip-Flop
74S195	C2	4-Bit Parallel-Access SR
74166	A3	8-Bit Shift Register
4116	C3-C10,D3-D10,E3-E10	16K x 1 Dynamic MOS RAM
9316B	F3,F5,F6,F8,F9,F11	2K x 8 Static NMOS ROM
8T28 (3)	H10,H11	4-Bit Parallel Bus Trans (3-St)
8T97 (4)	H3,H4,H5	Hex Buffer (3-State)
6502	H7/8	8-Bit NMOS Microprocessor
555	A13,B3	Timer
558	H13	Quad Timer
741C	K13	Compensated Op Amp
2513 (5)	A5	Character Generator ROM
MEMORY SEL	D1,E1,F1 (1)	RAM Configuration Block (6)
KEYBOARD	A7	Keyboard Connector
GAME I/O	J14	Game I/O Connector
Unused	A1,A4,A6,A14,F4,F7,F10,J2-J12	
Not Present	G,I	

Notes:
(1) Not present on Revision 7 and newer boards.
(2) May be replaced with 9334.
(3) Replaced with one 8304 at H11 on newer boards.
(4) May be replaced with 74LS367.
(5) Replaced with 2316B on Revision 7 and newer boards.
(6) RAM Configuration Blocks on Revision 0-6 boards allowed the use of 4096 (4K) chips in a given row.

Figure 8.2
Motherboard IC Index, by Chip Type (Logic Function)

Chip Type	Loc.	Apple Function
74LS00	A2	RAM Sel; LDPS; Soft 5
74LS02	A12	Clr Keyboard Strobe
	B13	Color; LDPS; Text Decode
	B14	Sync
74LS04	C11	Addr Buff Control
74LS08	B11	Phase 0; HiRes
	H1	HiRes/Page 2 Sel; ROM Decode
74LS11	B12	Color Burst; Mix Mode Sel; LD194 Gen
74LS20	D2	RAM Sel
74LS32	C14	Data Buff Control
74LS51	C13	Video Sync Mux
74LS74	A11	Pwr On Reset
	B10	Video Buff; Keyboard Strobe
	J13	Cassette Save
74LS138	F12	ROM Select
	F13	Addr Decode (Hdw Select)
	H2	Device Enable
	H12	I/O Select (Enable)
74LS139	E2 (1)	RAM Select
	F2	RAM Select
74LS151	A9	Video Select
74LS153	C1	Chip Select
	E11	MPU Video Addr Mux
	E12	MPU Video Addr Mux
	E13	MPU Video Addr Mux
74LS161	D11	Vert Sync
	D12	Vert Sync
	D13	Hor Sync
	D14	Hor Sync
74LS174	B5	Data Latch
	B8	Data Latch
74LS194	A10	Video Mode Latch
	B4	Graphics Shift Reg
	B9	Graphics Shift Reg
74LS251	H14	Data Select I/O
74LS257	A8	Video Gen Select
	B6	Keyboard Mux
	B7	Keyboard Mux
	C12	RAM Select
	J1	Address Mux
74LS259 (2)	F14	Text/Graphics Mode
74LS283	E14	MPU Video Addr Mux

Figure 8.3
Motherboard IC Index,
by Chip Type (System Function)

Chip Type	Loc.	Apple Function
74S86	B2	Video/Text; Sync; 14MHz Clk
74S175	B1	Color Ref; 7 Mhz Clk; Clk Phase 1
74S195	C2	RAS/CAS Clk
74166	A3	Text Shift Reg
4116	C3-C10	RAM $0000-$3FFF
	D3-D10	RAM $4000-$7FFF
	E3-E10	RAM $8000-$BFFF
9316B	F3	Monitor ROM ("F8"), $F800-$FFFF
	F5	Language ROM ("F0"), $F000-$F7FF
	F6	Language ROM ("E8"), $E800-$EFFF
	F8	Language ROM ("E0"), $E000-$E7FF
	F9	Lang/Misc ROM ("D8"), $D800-$DFFF
	F11	Lang/Misc ROM ("D0"), $D000-$D7FF
8T28 (3)	H10	Data Bus Buffer
	H11	Data Bus Buffer
8T97 (4)	H3	Addr Bus Buffer
	H4	Addr Bus Buffer
	H5	Addr Bus Buffer
6502	H7-8	Microprocessor
555	A13	Reset Timer
	B3	Cursor Flash Timer
558	H13	Game Paddle Timers
741C	K13	Cassette Read Amp
2513 (5)	A5	Character Generator
MEMORY SEL	D1 (1)	RAM Configuration Block
	E1 (1)	RAM Configuration Block
	F1 (1)	RAM Configuration Block
KEYBOARD	A7	Keyboard Connector
GAME I/O	J14	Game I/O Connector

Notes:
(1) Not present on Revision 7 and newer boards.
(2) May be replaced with 9334.
(3) Replaced with one 8304 at H11 on newer boards.
(4) May be replaced with 74LS367.
(5) Replaced with 2316B on Revision 7 and newer boards.

Figure 8.3 (Continued)
Motherboard IC Index,
by Chip Type (System Function)

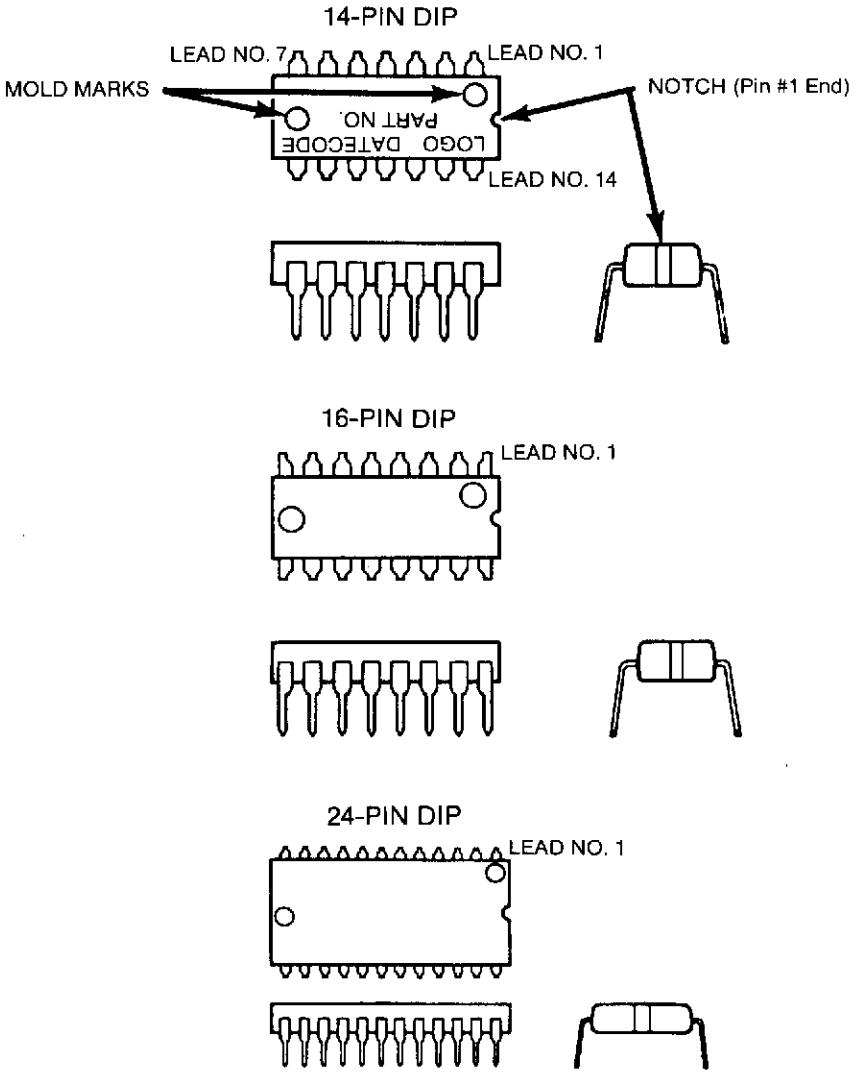
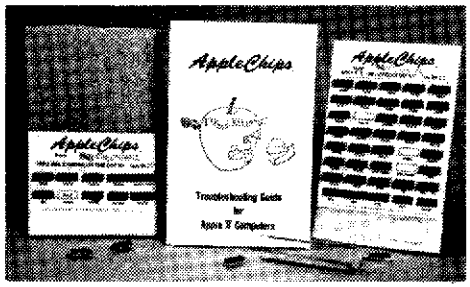


Figure 8.4
Chip Package Outlines

FIX YOUR APPLE][*YOURSELF* AND SAVE A **$BUNDLE!**



AppleChips™ Kits from Apple-Dayton provide step-by-step instructions and replacement IC's so anyone can fix most system failures. The extensive, easy to read manual makes diagnosing simple. The kit provides at least one of every IC you will need (except the 6502 Microprocessor and ROMS). Avoid one service call and you've paid for your kit! *NOT FOR //e.*

Motherboard Kit, Type MK-2-1

IC	Syst	Kit	IC	Syst	Kit	IC	Syst	Kit	IC	Syst	Kit
74LS00	1	1	74LS74	4	2	74LS194	3	2	74S195	1	1
74LS02	3	2	74LS125*	0	1	74LS251	1	1	74166	1	1
74LS04	1	1	74LS138	4	2	74LS257	5	2	555	2	1
74LS08	2	1	74LS139	2	1	74LS259	1	1	558	1	1
74LS11	1	1	74LS151	1	1	74LS283	1	1	741	1	1
74LS20	1	1	74LS153	4	2	74LS367	3	2	4116	24	2
74LS32	1	1	74LS161	4	2	74S86	1	1	8T28**	2	1
74LS51	1	1	74LS174	2	1	74S175	1	1	8304**	1	1

Syst=Qty in System Kit=Qty in Kit *=Disk][IC **=IC used depends on Rev. No.

Contains 41 IC's of 32 types, IC Puller and 40 page Troubleshooting Manual.

Disk][/Controller Kit, Type DK-2-1

IC	Syst	Kit	IC	Syst	Kit
74LS05	1 C	1	74LS323	1 C	1
74LS125	1 D	4	556	1 C	1
74LS132	1 C	1	CA3146A	1 D	2
74LS174	1 C	1	MC3470	1 D	1
74LS259	1 C	1	ULN2003	1 D	2

C=Controller Card D=Disk II Drive

Contains 15 IC's and Troubleshooting Manual.

Apple][/][+ Motherboard Chip Kit MK-2-1..... $49.95 Disk][Kit DK-2-1 ..... $34.95

Available through IAC MemberClubs at special prices, or order direct from Apple-Dayton.

Shipping/Handling add $2.00 per order.
COD add $1.50 per order.
Ohio residents add 5.5% sales tax.
Checks: Allow 2 weeks to clear.

APPLE·DAYTON
USERS GROUP IN DAYTON, OHIO

APPLE-DAYTON, INC.
POST OFFICE BOX 1666
FAIRBORN, OHIO 45324

Figure 8.5
ChipKits Contents

9.0 ABOUT APPLE-DAYTON

The following sections present information on the Apple-Dayton club organization, purpose and membership, on the origins of the *ChipKits* project, and special information for *ChipKits* customers.

9.1 APPLE-DAYTON CLUB OVERVIEW

Apple-Dayton, Inc. is a non-profit club (user's group) in Dayton, Ohio, serving those interested in the informed use of microcomputers. The major goals of the club are:

(1) To share knowledge about the applications, operation, programming and hardware of microcomputer systems.
(2) To acquire, review, improve, organize and distribute public domain computer programs for the benefit of the membership.

The ***Apple-Dayton Journal*** is the club's publication. Published monthly, twelve issues per year, it averages 45 pages of user-developed information to help you make the use of your computer more effective and fun. Articles include "How-to's" on a variety of topics, key-in programs, technical articles on understanding and modification of hardware and software, and discussions of various applications. It also features extensive reviews of current software from many areas of interest, and includes special columns on business, education, games, and adventure games. Also included are hardware reviews, Special Interest Group (SIG) activities, and club business. A description of each program on the Apple-Dayton Disk-of-the-Month is provided, along with a listing of all software and accessory items available for sale to members.

Apple-Dayton holds its primary (business) meetings at 7:30 PM on the second Thursday of each month. Currently meetings are held in the Medical Center Auditorium, or Oelman hall during summer, on the campus of Wright State University, Dayton, Ohio. Disk-of-the-Month sales begin at 6:30 PM, followed by a short business session and a presentation on a computer-related topic of general interest to the membership. Meetings are open to the public at no charge (membership NOT required). In addition, a User Information Exchange Meeting is held on the fourth Thursday of each month. It provides a question-answer forum for users of all experience levels. The meeting place is as announced in the Journal.

Classes in programming, hardware design and interfacing, system maintenance, etc., are presented periodically, at no cost to members, depending on demand and availability of qualified instructors.

The Club Librarian exchanges public domain software with other clubs, and provides the best possible selection of programs on the Disk-of-the-Month (DOM). In addition to a new DOM each month, special disk volumes on games (e.g. Eamon Adventures), Pascal, utilities, etc. are offered periodically. All Disk Library offerings from the prior twelve months are available to members for $5.00 each (for media and copying).

Membership in Apple-Dayton is open to all, and is $23.00 per year per family for new memberships and $18.00 per year for renewals. If a membership lapses, renewal is at the $23.00 rate. Membership is for twelve months from the date of dues payment, and provides the Apple-Dayton Journal and the right to purchase Apple-Dayton merchandise.

You are cordially invited to become a member of Apple-Dayton. The journal will provide valuable information on your Apple system, and you may purchase Apple-Dayton software and accessory products. To join, please complete the application form located elsewhere in this manual, and mail the form and your check to Apple-Dayton, P.O. Box 1666, Fairborn, Ohio 45324.

9.2 ORIGINS OF *ChipKits*

Life began in the ammonia and methane atmosphere of prehistoric earth, some three and one half billion years ago. Then Woz invented the Apple, and things began to get interesting. A sub-species of humans arose, called "Hackers", who have the in-bred trait of sticking their fingers into computers. More time went by, and it came to pass that more and more Apple owners were NON-Hackers, and were not at all comfortable with their fingers in their computers. It was in this environment in September 1982 that Dick Peschke, then President of the Apple-Dayton computer club, began writing a series of articles on troubleshooting the Apple II, especially for non-Hackers.

The troubleshooting articles were published in the ***Apple-Dayton Newsletter***, and were instrumental in convincing many non-Hackers and average users (i.e. those without a PhD in electronics) that chip-replacement Apple repair was enitrely practical and almost always successful, if not super-easy and fun. Using the step-by-step procedures presented, the user could usually narrow the cause of a failure to a small group of chips which could be replaced, one-by-one, until the computer started working again.

Two problems appear at this point, one obvious and one not so obvious. First (obvious), you must find at least one of each type of chip in the suspect sub-group of chips in order to make the substitutions.

Second (not so obvious), if a chip type isn't available from your neighborhood Radio Shack store, you may be out of business for a few weeks while you try to get the chip(s). It so happens that electronic parts distributors generally don't like to sell single chips to individuals, and mail orders take time. Also, several of the chips are uncommon enough that finding a supplier with stock can be a time consuming hassle. You can experience real sorrow by blowing a 8T28 chip on your motherboard, or a MC3470 chip in your disk drive, and find that it will take 12 to 16 weeks for delivery of another. You can buy the chips from your local computer dealer, and gain a full appreciation for the term "fiscal crisis". Or, you can give up and have the dealer service your system.

The challenge of finding chips AFTER the system had failed was not acceptable to the Apple-Dayton membership, so at their urging, motherboard and disk drive chip kits were developed. They were crude affairs, consisting of reprints of the Newsletter articles for a manual, and a bunch of chips stuck through aluminum foil into a styrofoam block. Even so, they met a need, and sold like hotcakes. They were a "cheap insurance policy" against that inevitable Friday evening chip failure. From that humble beginning the current Apple-Dayton *ChipKits* were developed; more chips, better packaging, and a completely revised and expanded manual. We at Apple-Dayton sincerely hope that the Type MK-2-1 (Apple][motherboard) and Type DK-2-1 (Disk][& Controller][) kits help you get more enjoyment and service from Woz's miracle machine.

9.3 USER FEEDBACK & MISC.

9.3.1 User Feedback

Apple-Dayton strives to make the *ChipKits* project as helpful as possible and the manual as thorough and accurate as possible. We therefore solicit feedback from our customers in many areas, especially in corrections to technical errors in the manual, additional techniques for inclusion in manual updates, suggestions on manual style and organization, suggestions for new products (e.g. individual chips), etc.

Substantive corrections or additions to the manual by registered *ChipKits* owners may qualify for an award of Apple-Dayton merchandise. The granting of an award and the type and quantity of merchandise is entirely at the discretion of the Apple-Dayton Board of Directors. If you have material to offer, please write to the Apple-Dayton, ATTN. Manager, *ChipKit* Project.

Returning the *ChipKits* Warranty card provides the above registration, activates warranty coverage, and places you on our mailing list for announcements of new Apple-Dayton products.

9.3.2 Misc.

This manual was written by Richard Peschke and Mason Friar, members of Apple-Dayton. We would like to express our appreciation to the many club members who assisted by suggesting servicing techniques, critiqueing the manual, proofreading, etc. The manual was typeset by Addy's Ink, Inc., Dayton, Ohio.

Warranty/Registration

Please return this Warranty/Registration card immediately to assure warranty coverage of your Apple-Dayton *ChipKits*, and to allow Apple-Dayton to mail you follow-up information.

Name: _____ Date: _____

Street: _____

City: _____ State: _____ Zip: _____

Motherboard Kit (MK-2-1): Qty. _____

Disk/Ctrlr Kit (DK-2-1): Qty. _____

Dealer Name: _____

Date Purchased: _____

Do you wish to receive Apple-Dayton mailings? Yes ☐ No ☐

Mail to:

ChipKits Mgr.
Apple-Dayton, Inc.
P.O. Box 1666
Fairborn, OH 45324

Apple-Dayton Membership Application

Name: _____ Date: _____

Street: _____

City: _____ State _____ Zip: _____

Phone: _____ Apple owner? ☐ Y ☐ N

Type of Membership (check one):

☐ New (@ $23.00) ☐ Renewal (@ $18.00)

Start membership with month of: _____

Mail Application and check to:

Apple-Dayton, Inc.
P.O. Box 1666
Fairborn, OH 45324

Make checks payable to Apple-Dayton, Inc.

ORDER FORM

Apple-Dayton, Inc.
P.O. Box 1666
Fairborn, OH 45324

Name: _____

Street: _____

City, State: _____

Zip: _____

Phone: _____

Quantity	Item Description	Unit Price	Item Total
		Ohio Residents add 5.5% sales tax	
		Shipping	**$2.00**
		TOTAL	

Prices:

Motherboard *ChipKit* with Manual (MK-2-1) $49.95

Disk II *ChipKit* with Manual (DK-2-1) $34.95